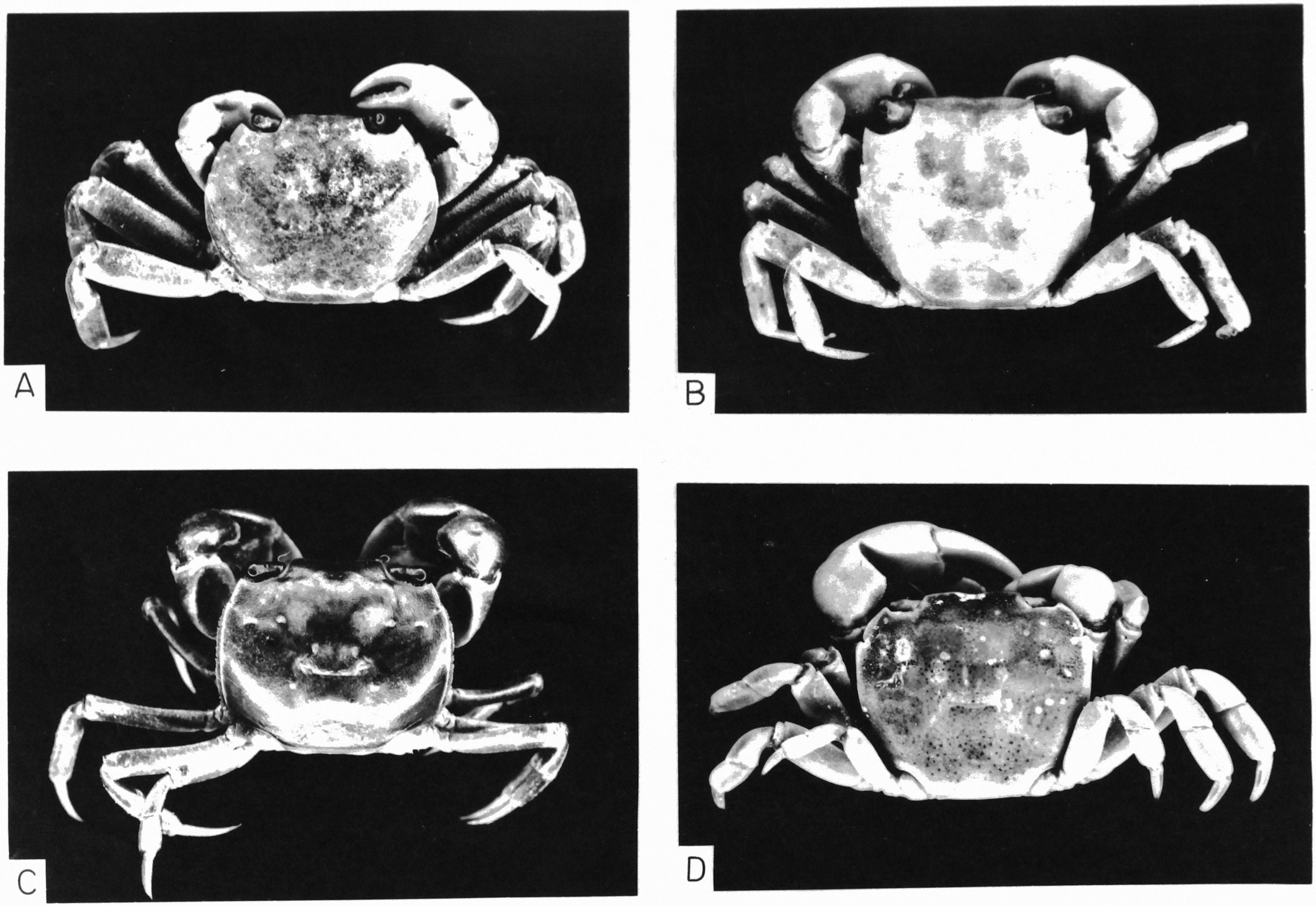

A
B
C
D

PLATE 2

Tasmanian Grapsidae in dorsal view

A, <u>Leptograpsodes</u> <u>octodentatus</u> (H. Milne Edwards)

Male, carapace length 26.1 mm (TM),

Pirate's Bay, Tasmania.

B, <u>Brachynotus</u> <u>spinosus</u> (H. Milne Edwards).

Male, carapace length 16.5 mm (TM),

Pittwater, Tasmania.

C, <u>Helograpsus</u> <u>haswellianus</u> (Whitelegge).

Male, carapace width 20.7 mm (TM),

Blackman Bay at mouth of Bream Ck., Tasmania.

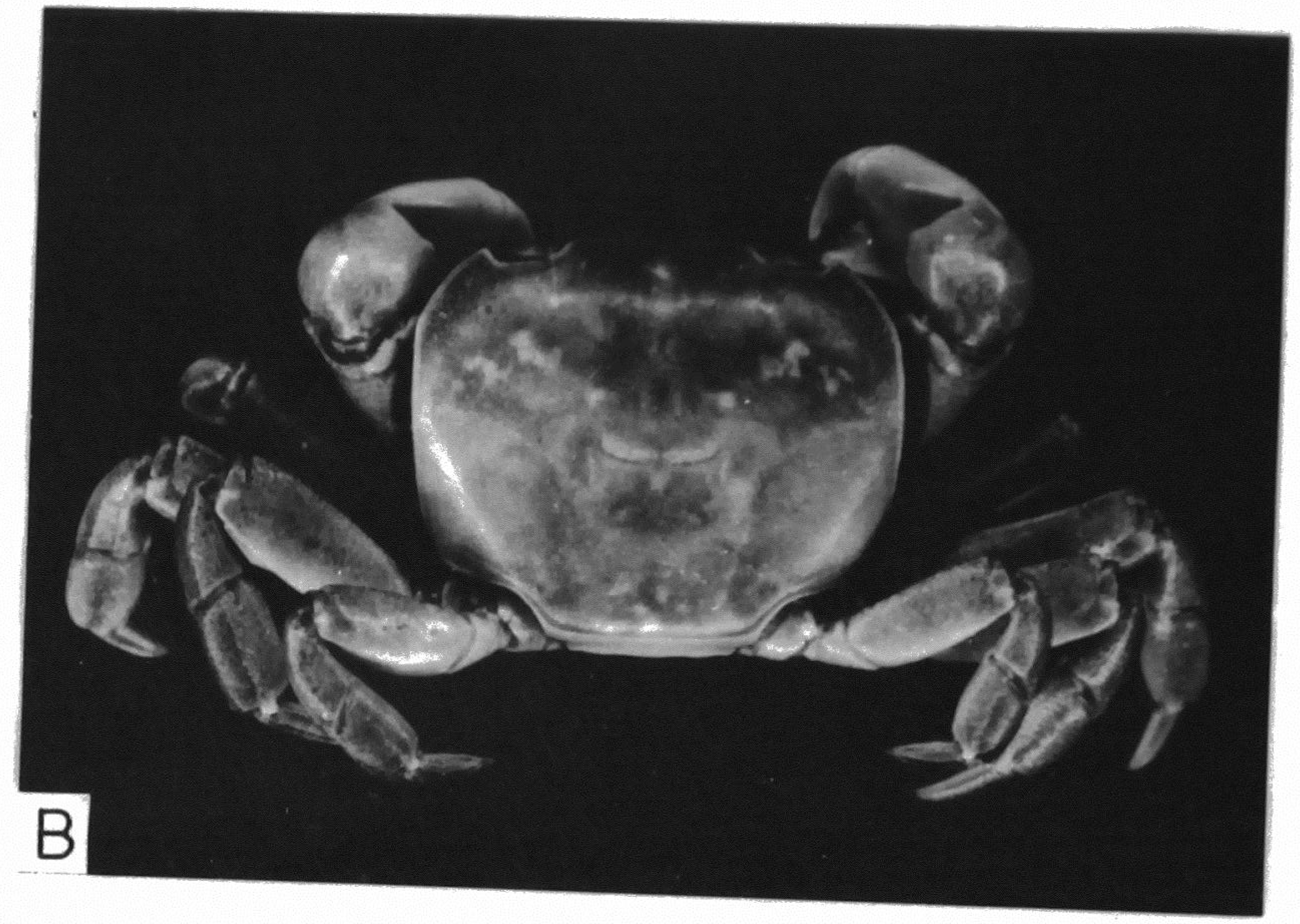
D, <u>Paragrapsus</u> <u>quadridentatus</u> (H. Milne Edwards).

Male, carapace width 23.6 mm (TM),

Pirate's Bay, Tasmania.

(Photographs: Athol Beswick)

A



B

C

D

PLATE 3

Southern temperate *Cyclograpsus* species in dorsal view

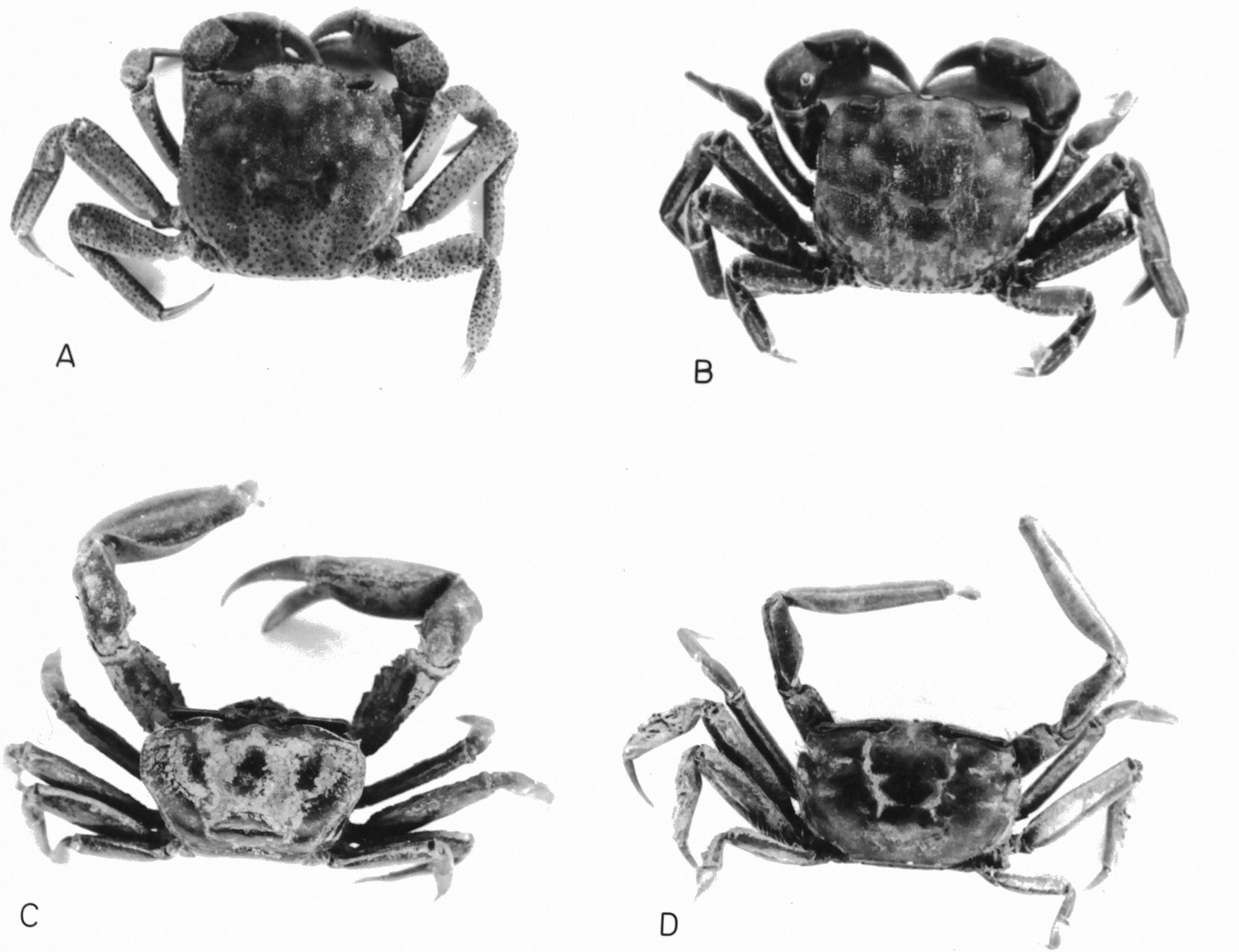
A, *C. granulosus* H. Milne Edwards.
Male, carapace width 31.5 mm (VM), "Victoria".

B, *C. audouinii* H. Milne Edwards.
Male, carapace width 26.0 mm (WAM 203.62), Woodman's Pt., Western Australia.

C, *C. lavauxi* H. Milne Edwards.
Male, carapace width 20.0 mm (DM), Island B., New Zealand.

D, *C. punctatus* H. Milne Edwards.
Male, carapace width 38.0 mm (SAM), "South Africa"

(Photographs: Athol Beswi



A B C D

PLATE 4

Tasmanian Grapsidae and Ocypodidae in dorsal view

A, <u>Paragrapsus gaimardii</u> (H. Milne Edwards).
Male, carapace width 36.2 mm (TM),
Norfolk Bay, Tasmania.

B, <u>Paragrapsus laevis</u> (Dana).
Male, carapace width 31.7 mm (TM),
Prosser R. at Orford, Tasmania.

C, <u>Heloecius cordiformis</u> (H. Milne Edwards).
Male, carapace width 22.0 mm (TM),
Double Ck., Tasmania.

D, <u>Hemiplax latifrons</u> (Haswell).
Male, carapace width 25.5 mm (TM),
near Wynyard, Tasmania.

(Photographs: Athol Beswick)

PLATE 5

Species of Plagusia in dorsal view

A, Plagusia capensis de Haan

Male, carapace length 62.8 mm (DM Cr 1223),

Castlepoint, New Zealand.

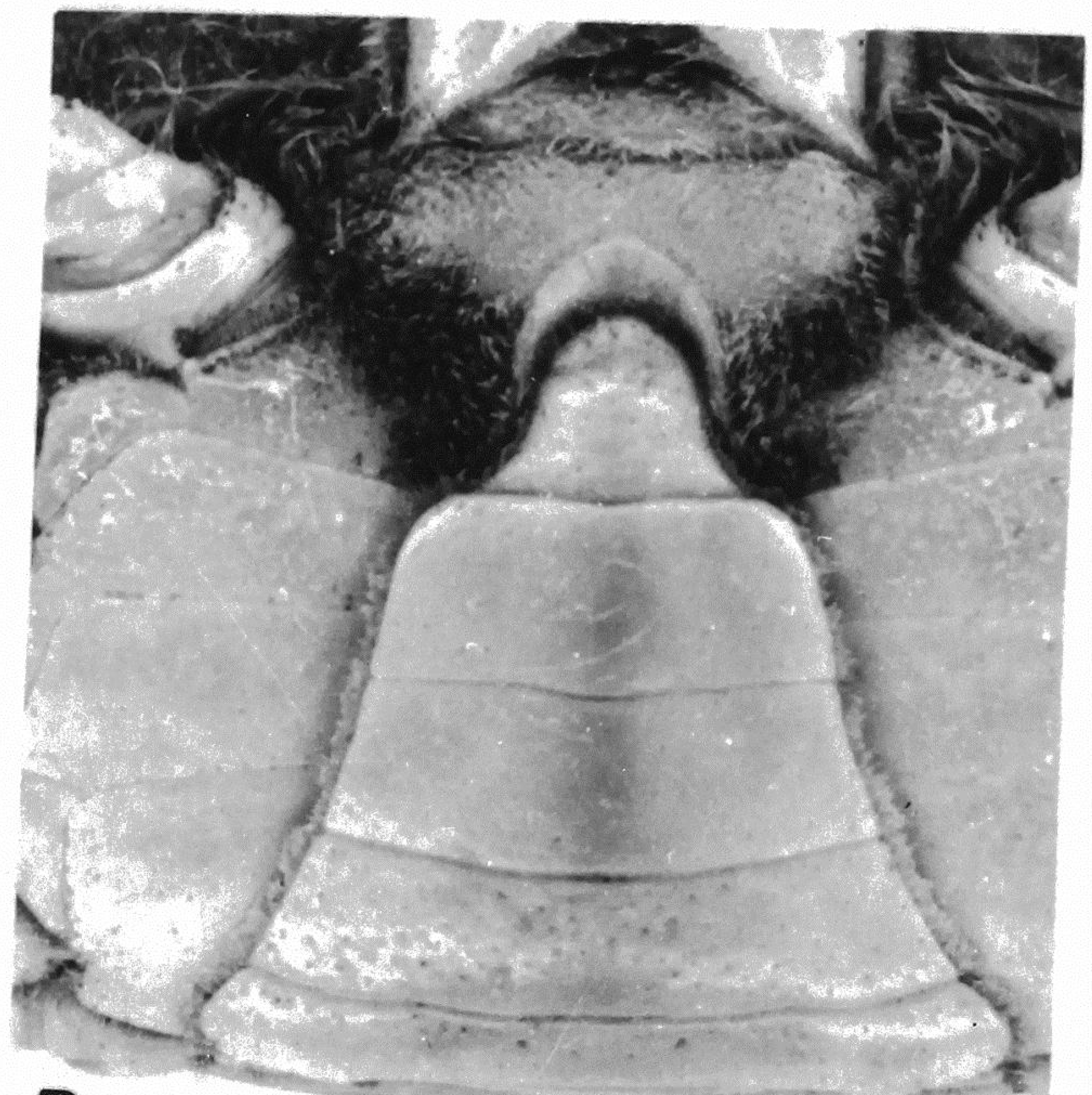
B, Plagusia dentipes de Haan

Male, carapace length 45.2 mm (USNM 33234),

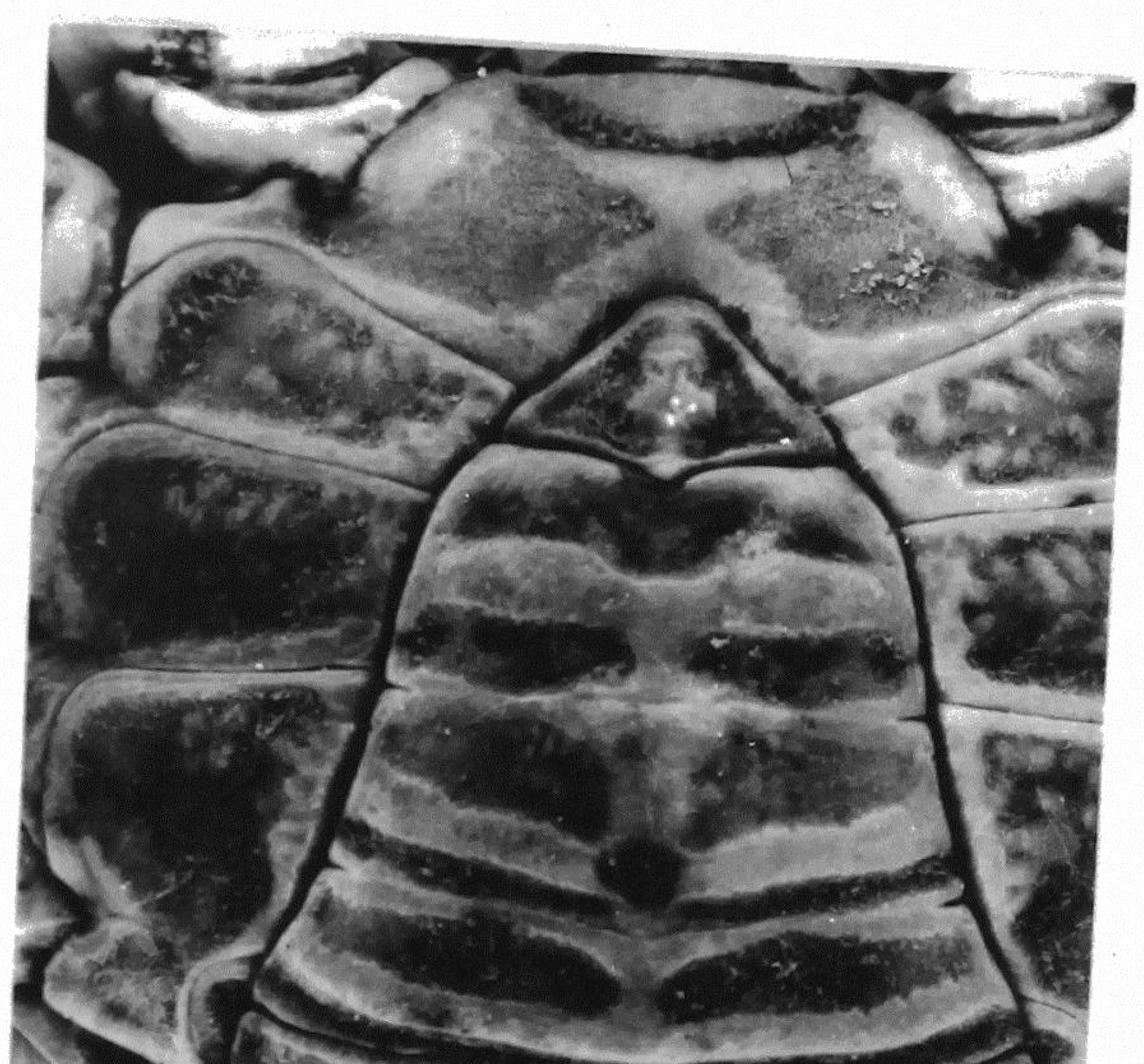
Easter I., Pacific Ocean.

(Photographs: Athol Beswic

A



B



C

D

PLATE 6

Male abdomens of Tasmanian grapsine and plagu

Grapsidae and related species

A, *Leptograpsus variegatus* (Fabricius).
Male, carapace length 53.0 mm (WAM 240.62),
Dorre I., Shark B., Western Australia.

B, *Leptograpsodes octodentatus* (H. Milne Edwards).
Male, carapace length 26.1 mm (TM),
Pirates B., Tasmania.

C, *Plagusia capensis* de Haan.
Male, carapace length 62.8 mm (DM Cr 1223),
Castlepoint, New Zealand.

D, *Plagusia dentipes* de Haan.
Male, carapace length 45.2 mm (USNM 33234),
Easter I., Pacific Ocean.

(Photographs: Athol Beswick)

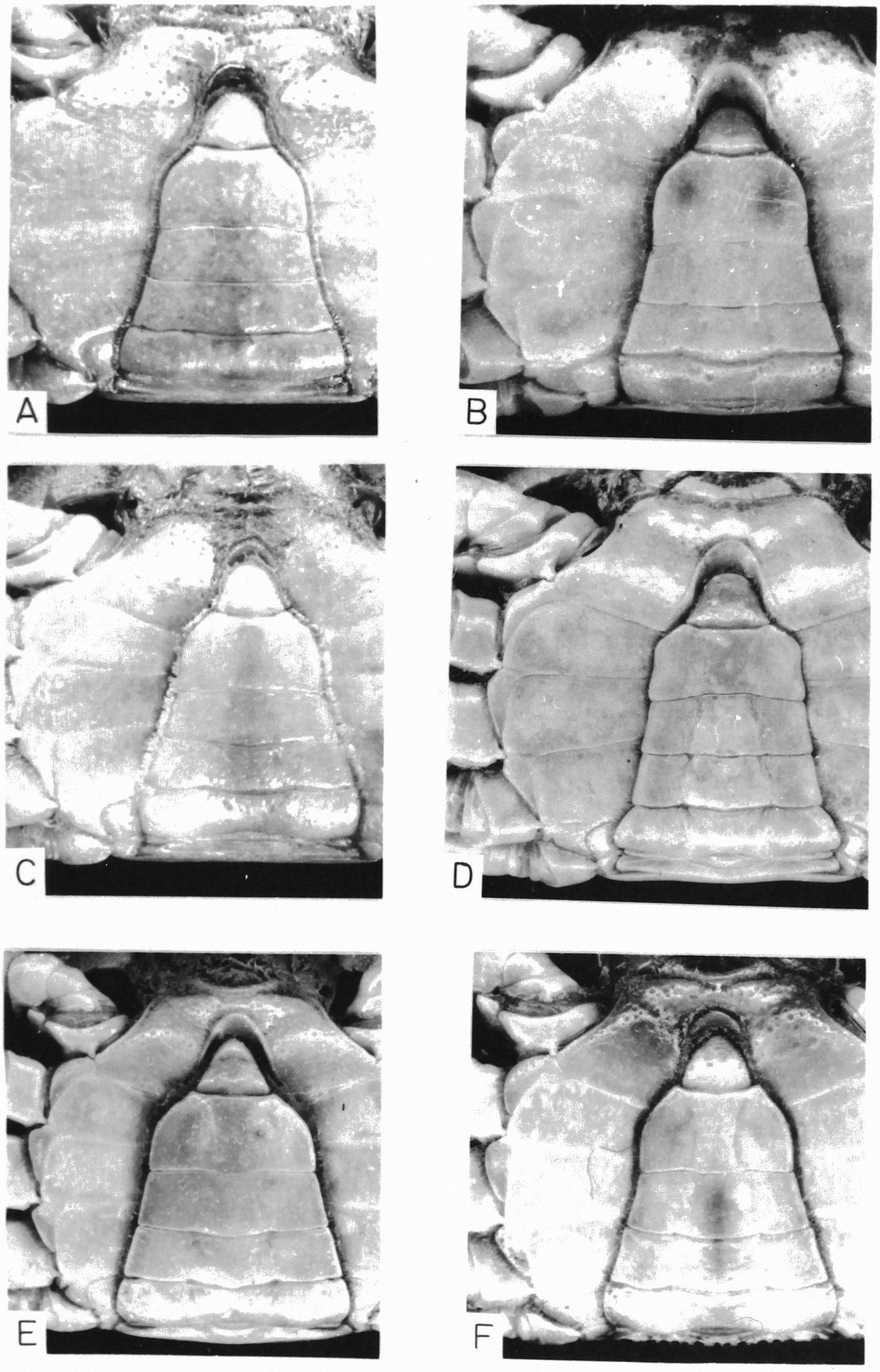

A
B
C
D
E
F

PLATE 7

Male abdomens of Tasmanian sesarminae

A, *Cyclograpsus granulosus* H. Milne Edwards.
Male, carapace width 27.0 mm (TM G1077),
Sandy Bay Rivulet, Tasmania.

B, *Cyclograpsus audouinii* H. Milne Edwards.
Male, carapace width 26.0 mm (WAM 203.62),
Woodman's Pt., Western Australia.

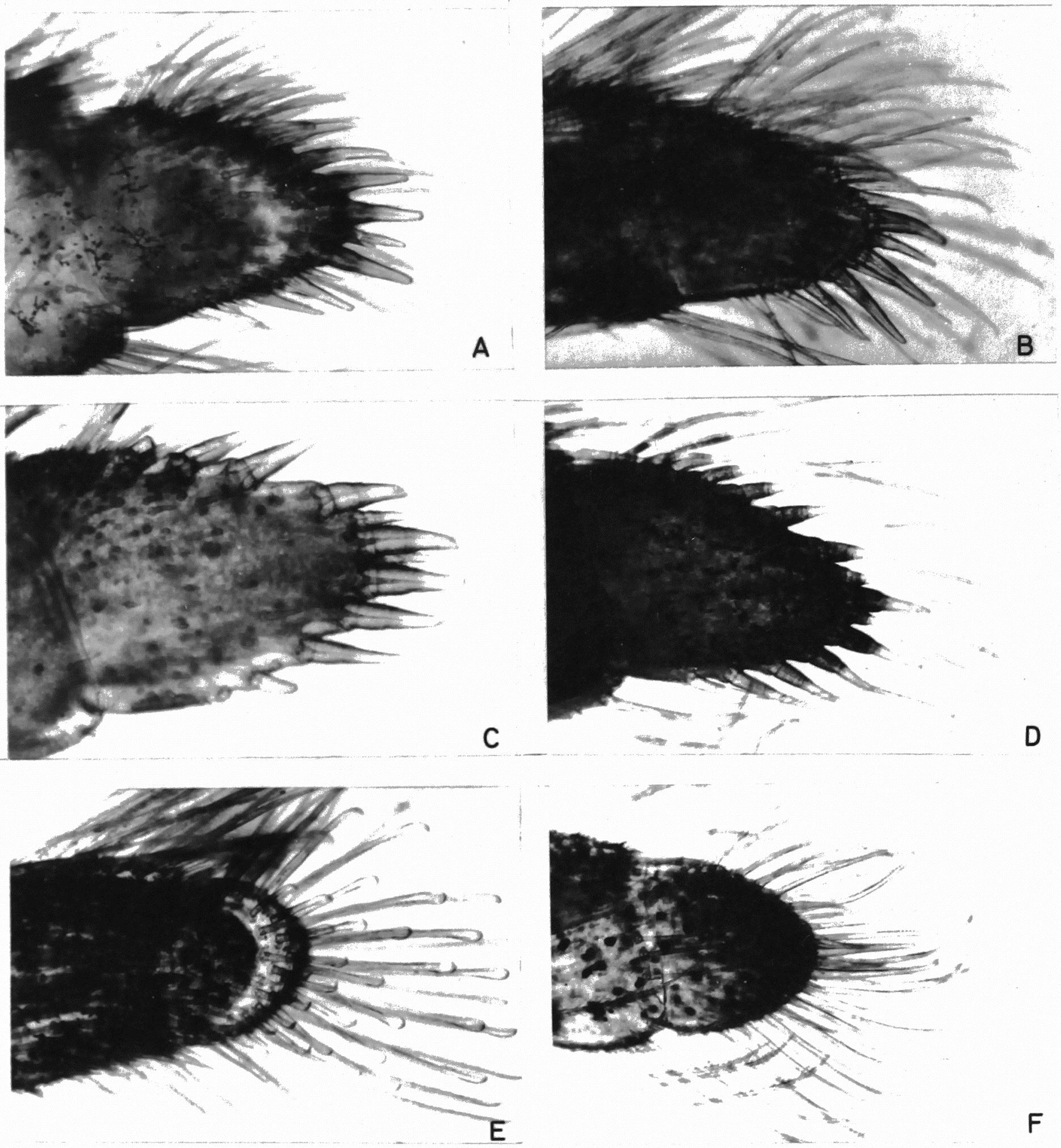
C, *Cyclograpsus lavauxi* H. Milne Edwards.
Male, carapace width 20.0 mm (DM),
Island B., New Zealand.

D, *Cyclograpsus punctatus* H. Milne Edwards.
Male, carapace width 30.0 mm (SAM), "South Africa

E, *Paragrapsus gaimardii* (H. Milne Edwards).
Male, carapace width 36.2 mm (TM),
Norfolk B., Tasmania.

F, *Paragrapsus laevis* (Dana)
Male, carapace width 31.7 mm (TM),
Prosser R. at Orford, Tasmania.

(Photographs: Athol Beswick)


A
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E
F

PLATE 8

Tip of palp of second left maxilliped, inner aspect, of six species of Tasmanian grapsids and ocypodi

A,	_Leptograpsodes octodentatus_	X 100
B,	_Brachynotus spinosus_	X 150
C,	_Paragrapsus quadridentatus_	X 100
D,	_Paragrapsus gaimardii_	X 70
E,	_Heloecius cordiformis_	X 100
F,	_Hemiplax latifrons_	X 100

(Photomicrographs: K.H. Lim and
Athol Beswic

PLATE 9

A, Bicheno

Fully exposed rock platform and boulders. This is the typical habitat of Leptograpsus variegatus which shelters in the numerous horizontal crevices and feeds over the platform and boulders. The infralittoral fringe formed by the strapweed (Durvillea potatorum) is obvious.

B, Prosser River at Orford

Estuary inhabited by Paragrapsus laevis, P. gaimardii, Hemiplax latifrons which live in burrows in the wetter parts of the marsh low down on the shore and Heloecius cordiformis which lives in burrows in the upper marsh where the substrate ranges from only slightly muddy sand to clay. The soldier crab (Myctiris platycheles) lives on the upper shore in burrows in the sandier areas.

(Photographs: D.J.G. Griffin and Athol Beswick)

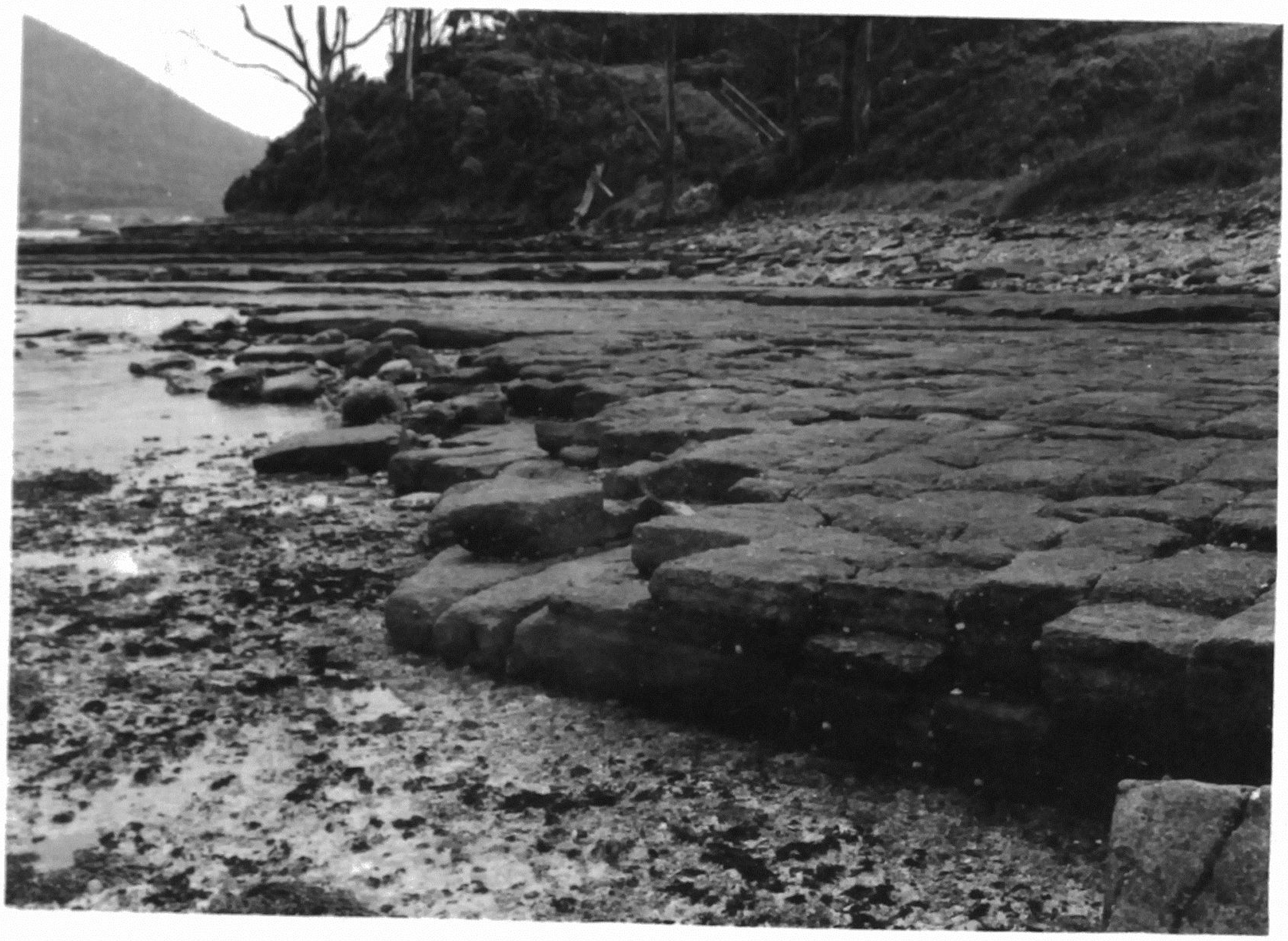


PLATE 10

A, Pirates Bay

View of the "Tesselated Pavements"

a semi-exposed rock platform.

Plagusia capensis is found in the infralittoral, *Paragrapsus quadridentatus* is present in the low midlittoral and *Cyclograpsus granulosus* in the upper midlittoral under scattered boulders. *Leptograpsodes octodentatus* is found on the boul beach fringing the platform in the middle distanc

B, North-West Bay at Howden

View of sandstone platform and scattered remnant pools. This sheltered bay is the habitat of *Brachynotus spinosus* which is found under stones in the pools. *Cyclograpsus granulosus*, *Paragraps quadridentatus* and *P. gaimardii* are found under stones and *Hemiplax latifrons* lives in burrows in the mud flats in the middle distance.

(Photographs: Athol Beswick)

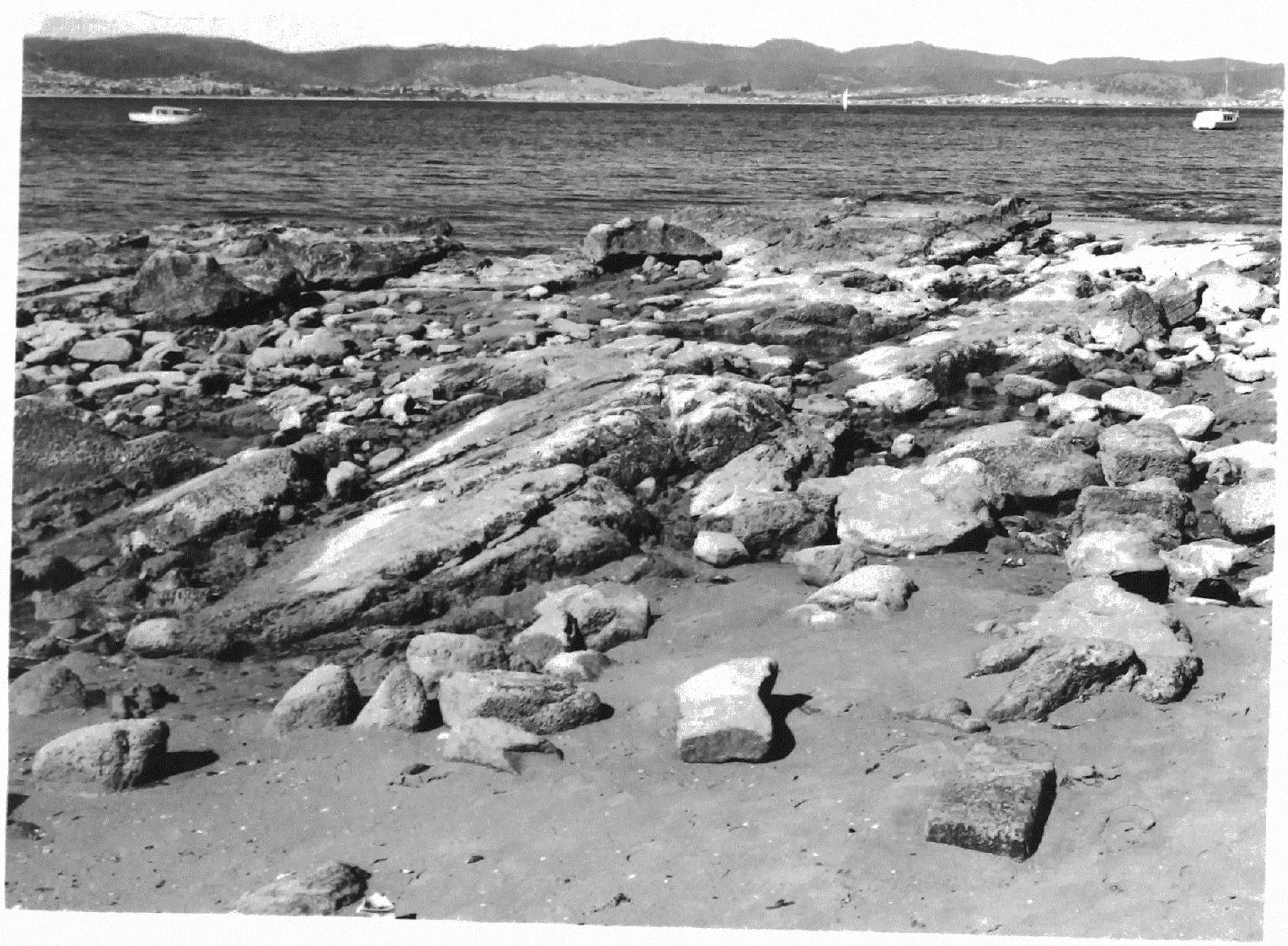


PLATE 11

A, Crayfish Pt., Taroona, River Derwent

A semi-exposed boulder beach, the typical habitat of _Cyclograpsus granulosus_ which here extends thr out the midlittoral. The boulders in the lower midlittoral are covered by masses of mussels and tubicolous polychaetes.

B, Sandy Bay, River Derwent

A sheltered boulder and stony beach. _Paragrapsus quadridentatus_, and _P. gaimardii_ are found in the lower midlittoral under stones and _Cyclograpsus granulosus_ in the upper midlittoral also under stones. _Brachynotus spinosus_ is also found here

The rocks in the lower midlittoral are covered by masses of tubicolous polychaetes (_Galeolaria caespritosa_) and in the upper midlittoral and abo by littorinid snails (_Melarapha unifasciata_) and barnacles (_Elminius modestus_).

(Photographs: Athol Beswick)

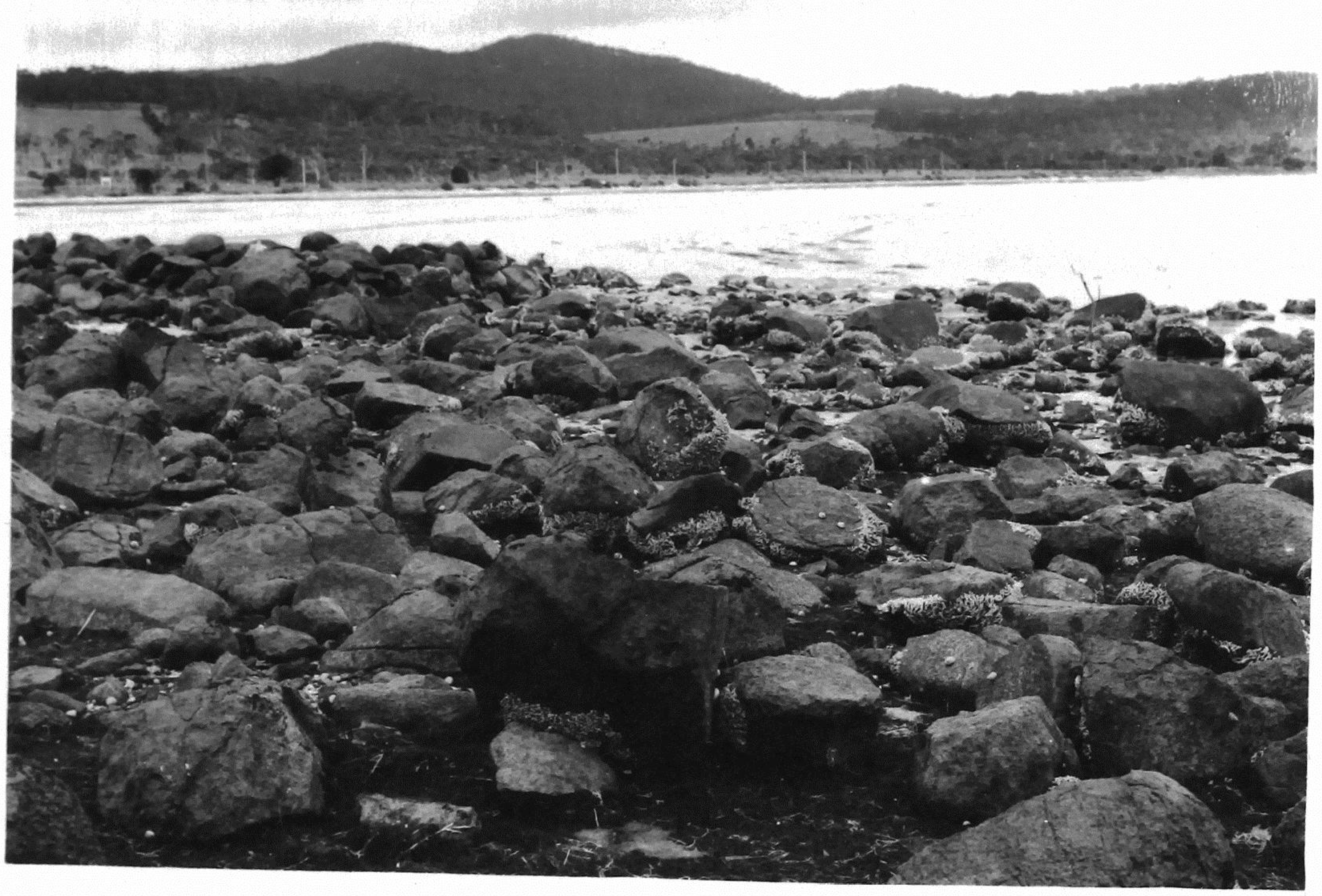


PLATE 12

A, Dunalley Bay

A sheltered boulder beach forming the upper frin
of an extensive sandy estuary. Paragrapsus
gaimardii, P. quadridentatus, Cyclograpsus granu
losus and Brachynotus spinosus are all found und
the boulders.

The lower surfaces of the boulders are covered
masses of tubicolous polychaetes (Galeolaria
caespitosa).

The soldier crab (Myctiris platycheles) inhabit
the sandy beach in the distance.

B, Elwick Bay, River Derwent.

A sheltered stony beach and sandy muddy estuar
Paragrapsus gaimardii is found under the scatt
stones in the lower midlittoral (foreground) an
Helograpsus haswellianus under stones in the u
midlittoral and in burrows in the clay bank in
supralittoral.

(Photographs: Athol Beswick)

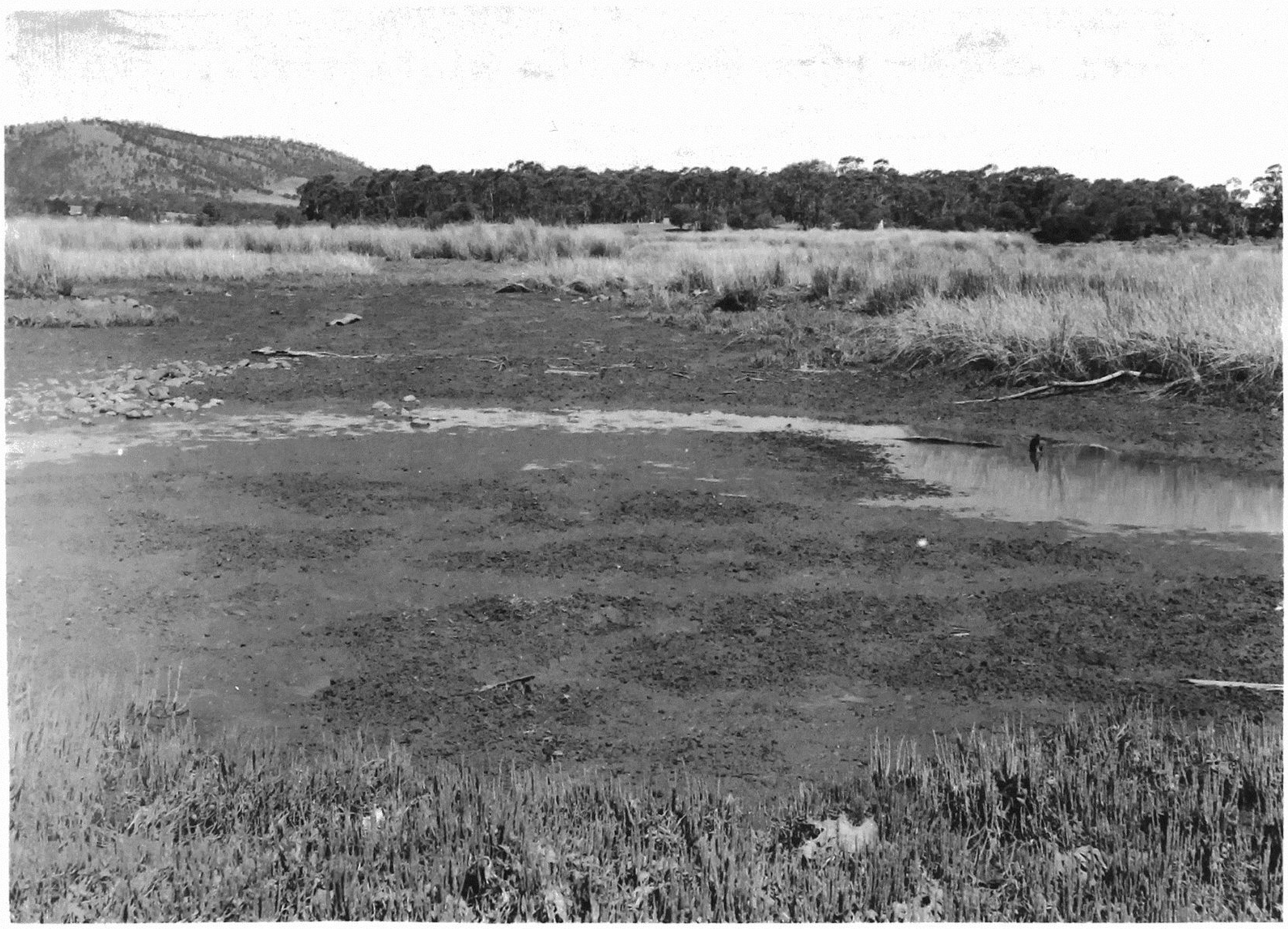


PLATE 13

A, Pittwater

A view from the top of the shore showing the sand stone platform and scattered stones, the typical habitat of *Brachynotus spinosus* in the upper mid- littoral and supralittoral. On the lower shore *Paragrapsus gaimardii* is found under stones and *Hemiplax latifrons* and the soldier crabs (*Myctiris platycheles*) are found in burrows.

B, Margate

A muddy estuary, the typical habitat of the ocy- podids, *Heloecius cordiformis* which lives in burr in the drier mounds and *Hemiplax latifrons* which lives in burrows in the wetter runnels and under water. *Helograpsus haswellianus* is found in the supralittoral in burrows on the bank.

(Photographs: Athol Beswick)

PLATE 14

A, Blackman Bay, mouth of Bream Creek.

Sheltered estuary fringed by a clay bank. *Paragrapsus laevis* is found in deep burrows in the bank and *P. gaimardii* is found in burrows and under stones in the stream bed.

B, Double Creek

View towards the mouth of the creek. *Paragrapsus laevis* and *P. gaimardii* are found under stones throughout the midlittoral. *Heloecius cordiformis* and *Hemiplax latifrons* are found in burrows in the muddy areas free from stones.

(Photographs: D.J.G. Griffin and Athol Beswick).

APPENDIX I STATISTICAL FORMULAE

Linear regressions are calculated by the method of least squares (Bailey, 1959) and are given in the form $y = a + bx$ where y is the dependent, and x the independent, variable; a is the intercept on the y axis and b the regression coefficient. Standard errors of a and b are calculated according to the formulae given by Fisher (1954) and Davies (1957).

Comparison of regressions follows the method given by Simpson and Roe (1937).

Calculation of other statistical estimates mainly follows Bailey (1959).

In the analysis of data on behaviour in relation to fresh water (table 15 and text-figure 42) the variance of the mean was calculated as pq/n (Davies, 1957: 227) where

p = percentage remaining in fresh water

$q = 1 - p$

and n = the number of replicates for each time.

In table 16 the 95% confidence limits of the mean for 50% emigration were calculated as

$$1.96\,\frac{s}{b}\sqrt{\frac{1}{m}+\frac{1}{n}+\frac{(y_k-\bar{y})^2}{b\sum(x-\bar{x})(y-\bar{y})}}$$

where $s = \sqrt{\text{mean square about the regression}}$;

b is the regression coefficient;

m is the geometric mean of number of replicates for the whole regression (here taken as 1);

n is the number of paired observations;

and y_k is any particular value of y

(in this case 50%, or 45.00 in angles) (see Davies, 1957: 170-3).

In all these experiments the means are calculated from the pooled results, each replicate being considered to comprise a number of independent concurrent experiments in separate chambers. Calculation of means and regressions takes into account only those crabs remaining in water, those which moved on to the sides of the chamber being excluded.

TABLE I Values for constants associated with regressions dealt with in the text. The x and y columns give the name of the independent and dependent variables respectively. The a and b columns give the values of a and b (in equation of the form $y = a + bx$) respectively; the second row in these two columns gives the sums of squares due to the regression as a percentage of the total sums of squares (n is the number groups of paired observations used in calculation of the regressions).

Species	Fig.	x	y	a	b	significance (n)
L. variegatus	5A	carapace length	carapace width	-0.60 (0.296)	1.16 (0.017)	99.8 (12)
"	"	"	interorbital width	5.10 (0.274)	0.68 (0.016)	99.4 (12)
"	"	"	anterolateral margin length	1.32 (0.610)	0.52 (0.035)	95.6 (12)
C. granulosus	15A	frontal width	anterolateral margin length	-0.39 (0.076)	0.31 (0.026)	99.3 (10)
C. audouinii	"	"	"	0.20 (0.117)	0.32 (0.046)	98.3 (9)
P. capensis	21	carapace length	carapace width (spine 3)	0.63 (0.149)	1.06 (0.080)	99.9 (13)

Table I, continued.

Species	Fig.	x	y	a	b	significance (n)
P. capensis	21	carapace length	carapace width (spine 2)	0.59 (0.179)	0.97 (0.096)	99.9 (13)
"	"	"	carapace width (spine 1)	2.99 (0.185)	0.79 (0.099)	99.8 (13)
"	"	"	interorbital width	4.46 (0.308)	0.54 (0.164)	99.0 (13)
"	"	" "	frontal width	1.25 (0.011)	0.20 (0.057)	98.9 (13)
"	22B	carapace length	number of spines on b. ant. art.	1.06 (0.178)	0.04 (0.009)	61.5 (13)
"	23A	"	number of spines on ant. b. mth.	10.08 (0.343)	-0.02 (0.018)	13.5 (13)
" (juveniles)	22B	"	number of spines on s. orb. b.	42.35 (0.037)	-1.55 (0.398)	80.3 (3)

Table 1, continued.

Species	Fig.	x	y	a	b	significance (n)
P. capensis (adults)	23B	carapace length	number of spines on s. orb. b.	12.68 (1.626)	-0.07 (0.003)	93.8 (9)
P. capensis	24	length ambulatory merus 3	number of dorsal spines	4.85 (0.511)	0.18 (0.039)	75.1 (9)
H. cordiformis	42	log. time	% remaining in f.w.	93.92 (1.62)	-24.97 (3.90)	89.1 (7)
L. octodentatus	"	"	"	65.68 (1.10)	-14.26 (2.65)	85.2 (7)
H. haswellianus	"	"	"	95.67 (2.13)	-37.07 (5.15)	91.3 (7)
P. gaimardii	"	"	"	78.78 (1.57)	-29.89 (3.79)	92.6 (7)
H. latifrons	"	"	"	66.04 (1.16)	-28.62 (3.40)	94.7 (6)

Table 1, continued.

Species	Fig.	x	y	a	b	significance (n)
C. granulosus	42	log. time	% remaining in f.w.	65.64 (3.35)	-30.12 (12.58)	63.50 (5)
BB. spinosusq	"	"	"	66.98 (2.09)	-35.02 (7.84)	86.90 (5)
P. quadridentatus	"	"	"	64.57 (1.71)	-35.45 (6.44)	75.60 (5)

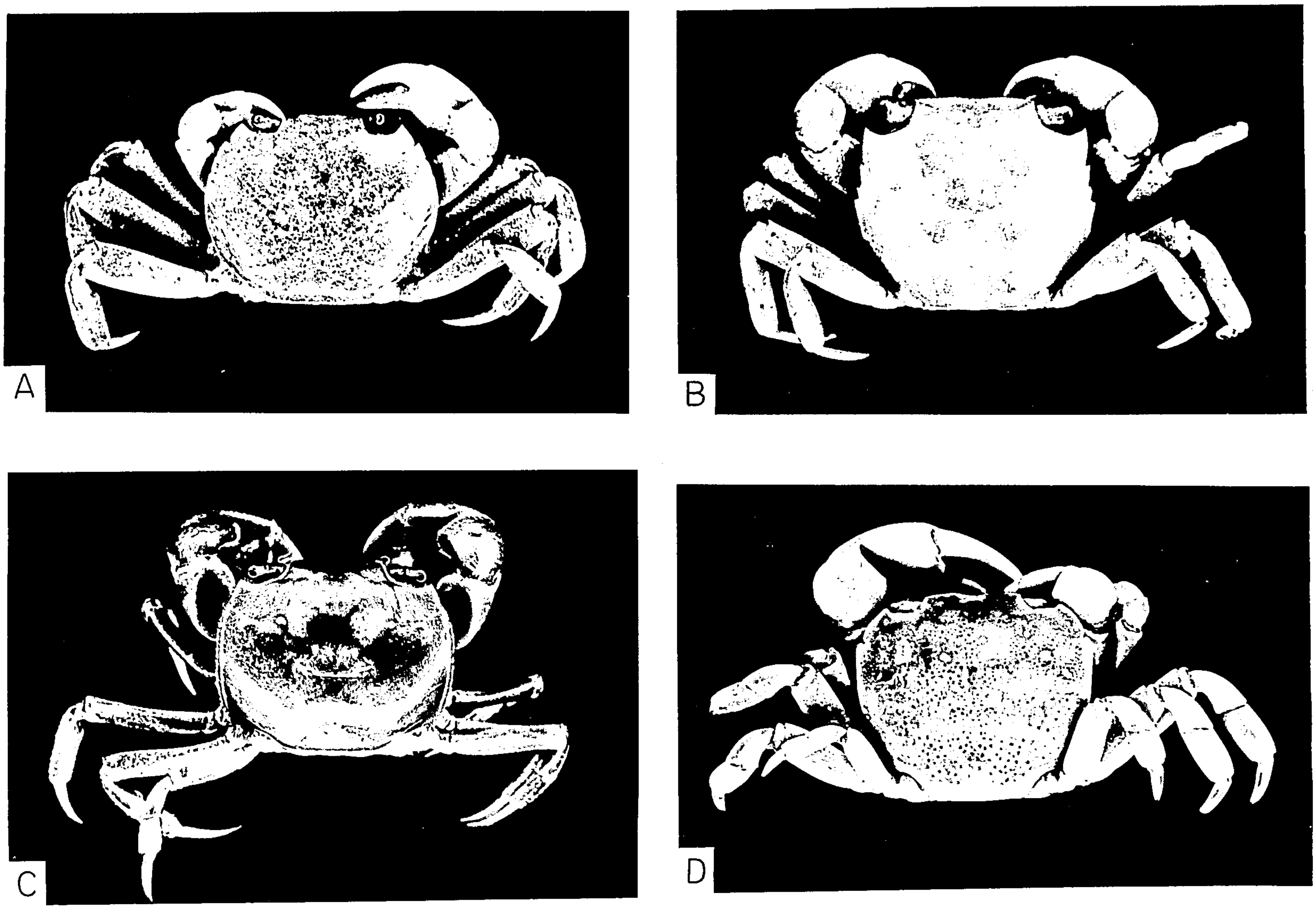


PLATE 2

Tasmanian Grapsidae in dorsal view

A, *Leptograpsodes octodentatus* (H. Milne Edwards)

Male, carapace length 26.1 mm (TM),

Pirate's Bay, Tasmania.

B, *Brachynotus spinosus* (H. Milne Edwards).

Male, carapace length 16.5 mm (TM),

Pittwater, Tasmania.

C, *Helograpsus haswellianus* (Whitelegge).

Male, carapace width 20.7 mm (TM),

Blackman Bay at mouth of Bream Ck., Tasmania.

D, *Paragrapsus quadridentatus* (H. Milne Edwards).

Male, carapace width 23.6 mm (TM),

Pirate's Bay, Tasmania.

(Photographs: Athol Beswick)

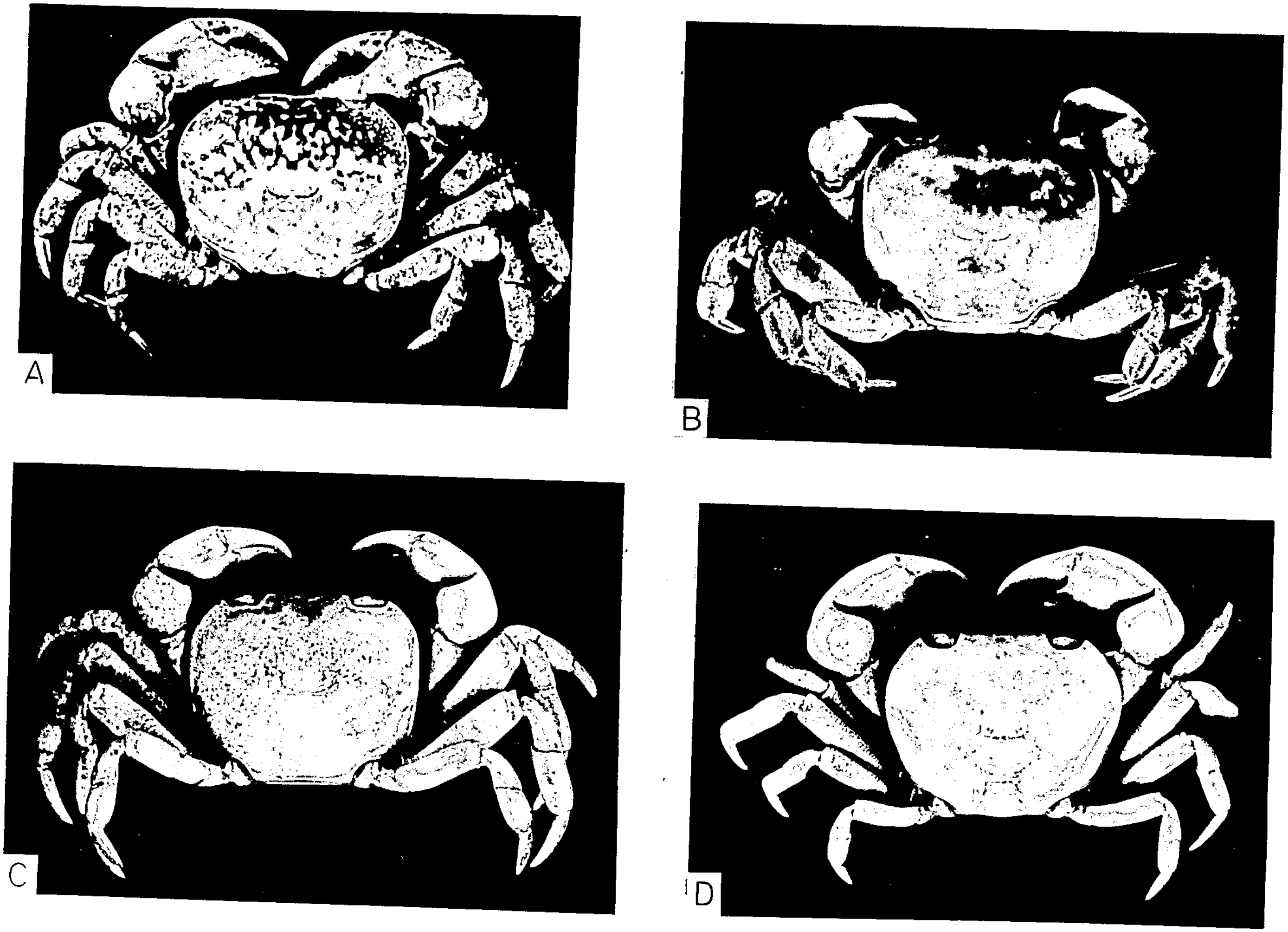

A
B
C
D

PLATE 3

Southern temperate *Cyclograpsus* species in dorsal view

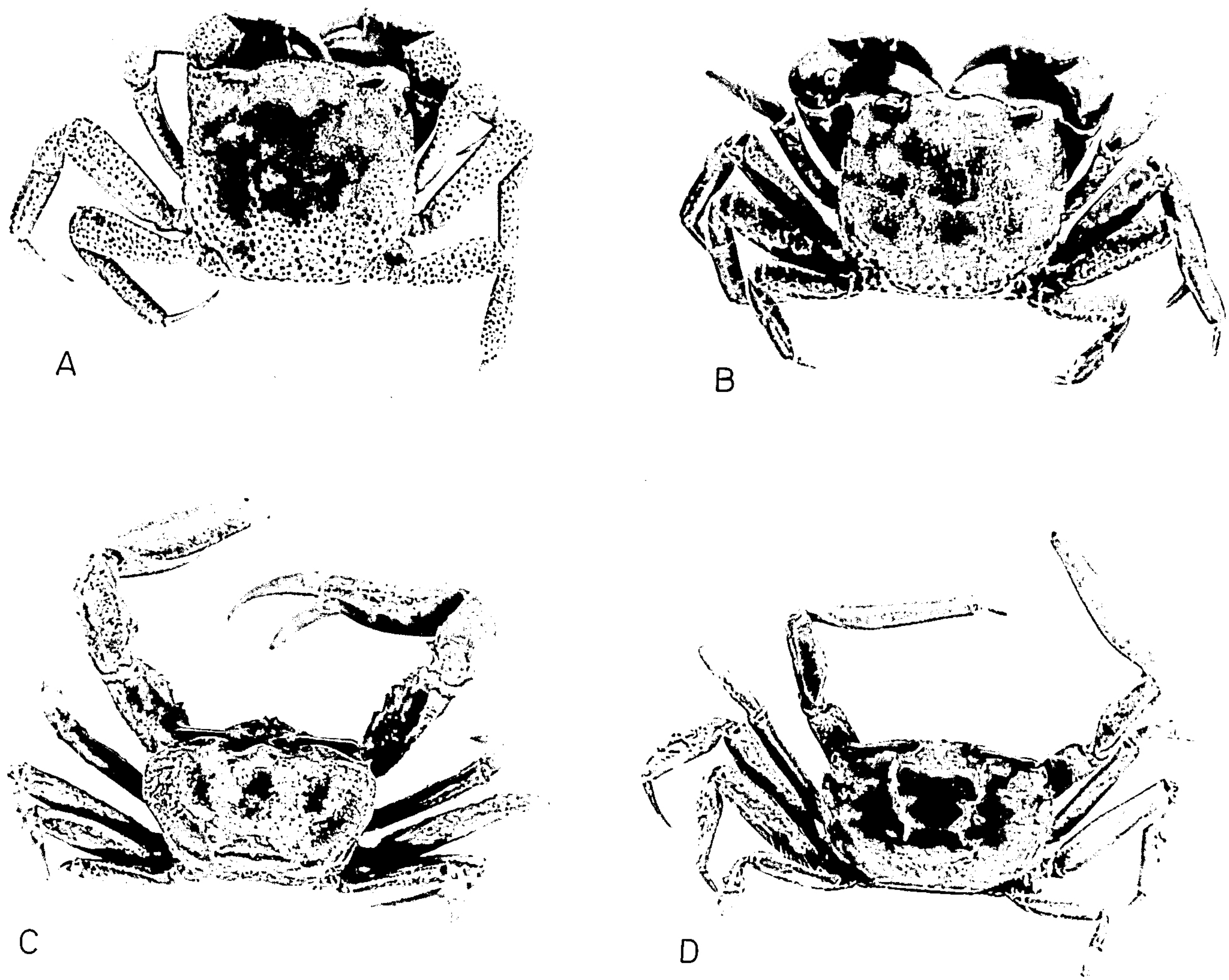
A, *C. granulosus* H. Milne Edwards.
Male, carapace width 31.5 mm (VM), "Victoria".

B, *C. audouinii* H. Milne Edwards.
Male, carapace width 26.0 mm (WAM 203.62), Woodman's Pt., Western Australia.

C, *C. lavauxi* H. Milne Edwards.
Male, carapace width 20.0 mm (DM), Island B., New Zealand.

D, *C. punctatus* H. Milne Edwards.
Male, carapace width 38.0 mm (SAM), "South Africa".

(Photographs: Athol Beswick)



A
B
C
D

PLATE 4

Tasmanian Grapsidae and Ocypodidae in dorsal view

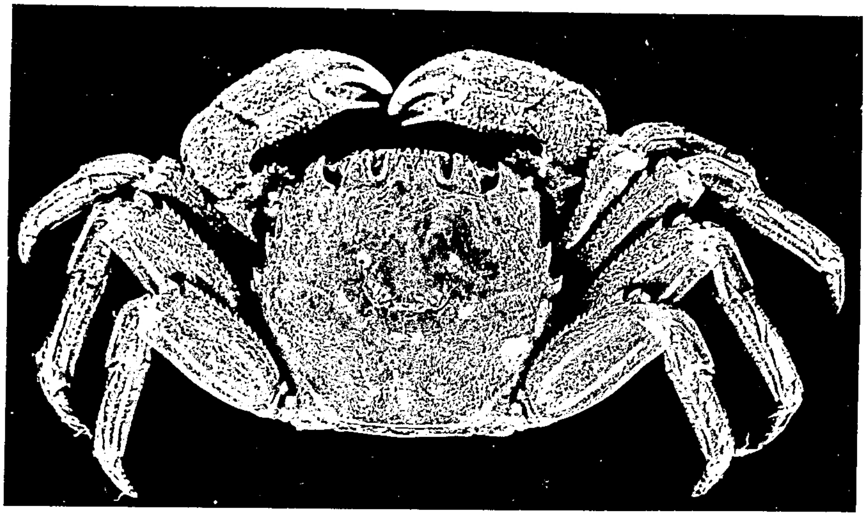
A, *Paragrapsus gaimardii* (H. Milne Edwards).
Male, carapace width 36.2 mm (TM),
Norfolk Bay, Tasmania.

B, *Paragrapsus laevis* (Dana).
Male, carapace width 31.7 mm (TM),
Prosser R. at Orford, Tasmania.

C, *Heloecius cordiformis* (H. Milne Edwards).
Male, carapace width 22.0 mm (TM),
Double Ck., Tasmania.

D, *Hemiplax latifrons* (Haswell).
Male, carapace width 25.5 mm (TM),
near Wynyard, Tasmania.

(Photographs: Athol Beswick)



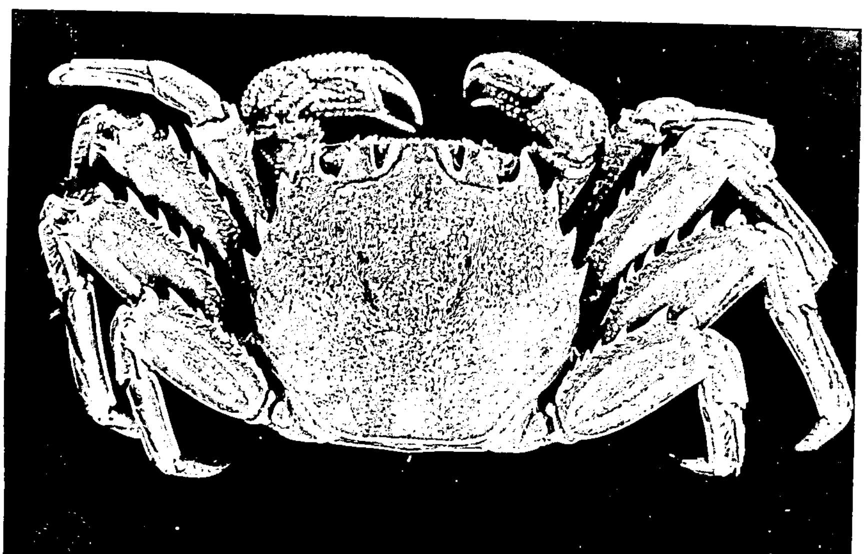


PLATE 5

Species of *Plagusia* in dorsal view

A, *Plagusia capensis* de Haan

Male, carapace length 62.8 mm (DM Cr 1223), Castlepoint, New Zealand.

B, *Plagusia dentipes* de Haan

Male, carapace length 45.2 mm (USNM 33234), Easter I., Pacific Ocean.

(Photographs: Athol Beswick)

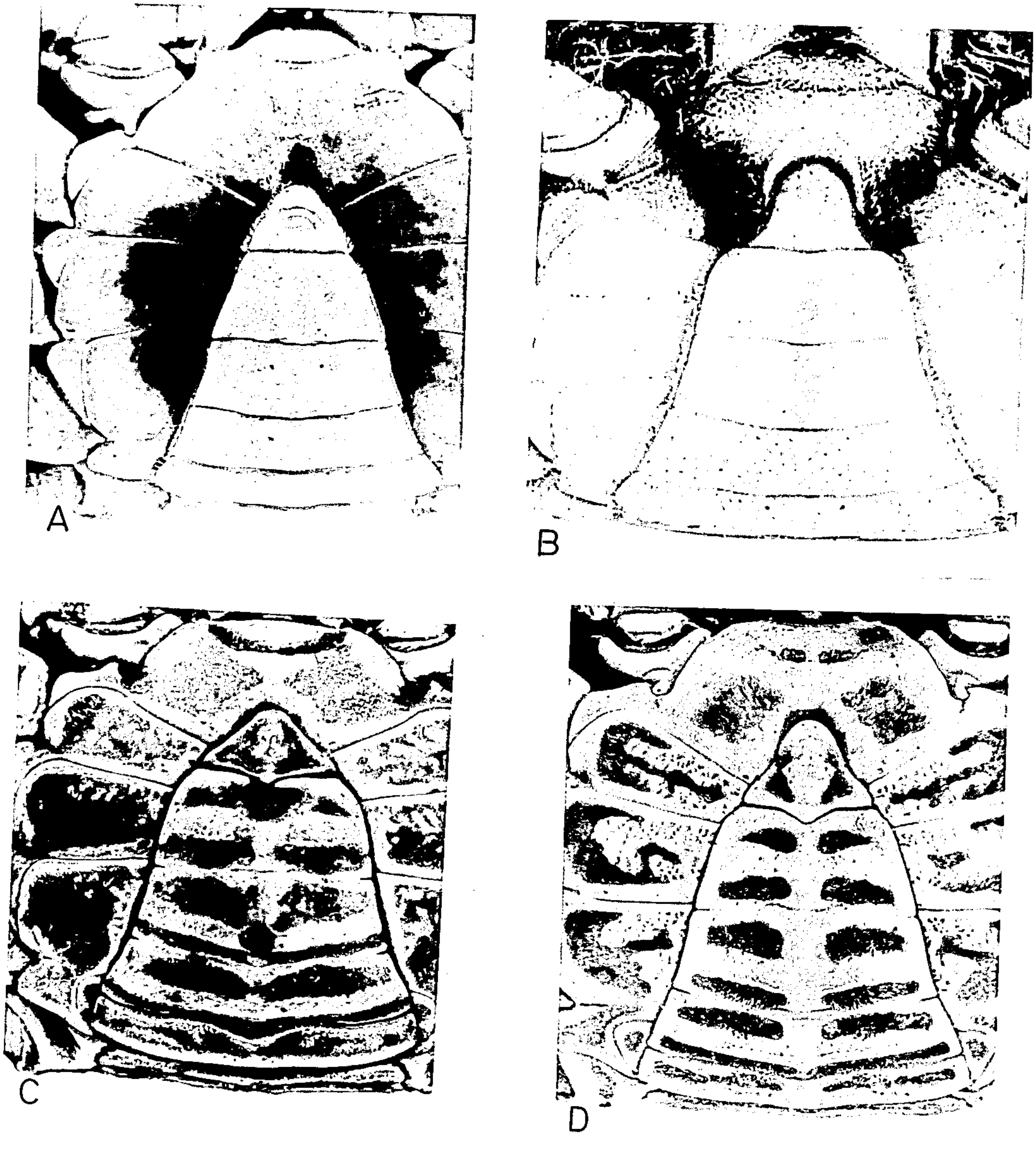

A
B
C
D

PLATE 6

Male abdomens of Tasmanian grapsine and plagusiine Grapsidae and related species

A, Leptograpsus variegatus (Fabricius).
Male, carapace length 53.0 mm (WAM 240.62),
Dorre I., Shark B., Western Australia.

B, Leptograpsodes octodentatus (H. Milne Edwards).
Male, carapace length 26.1 mm (TM),
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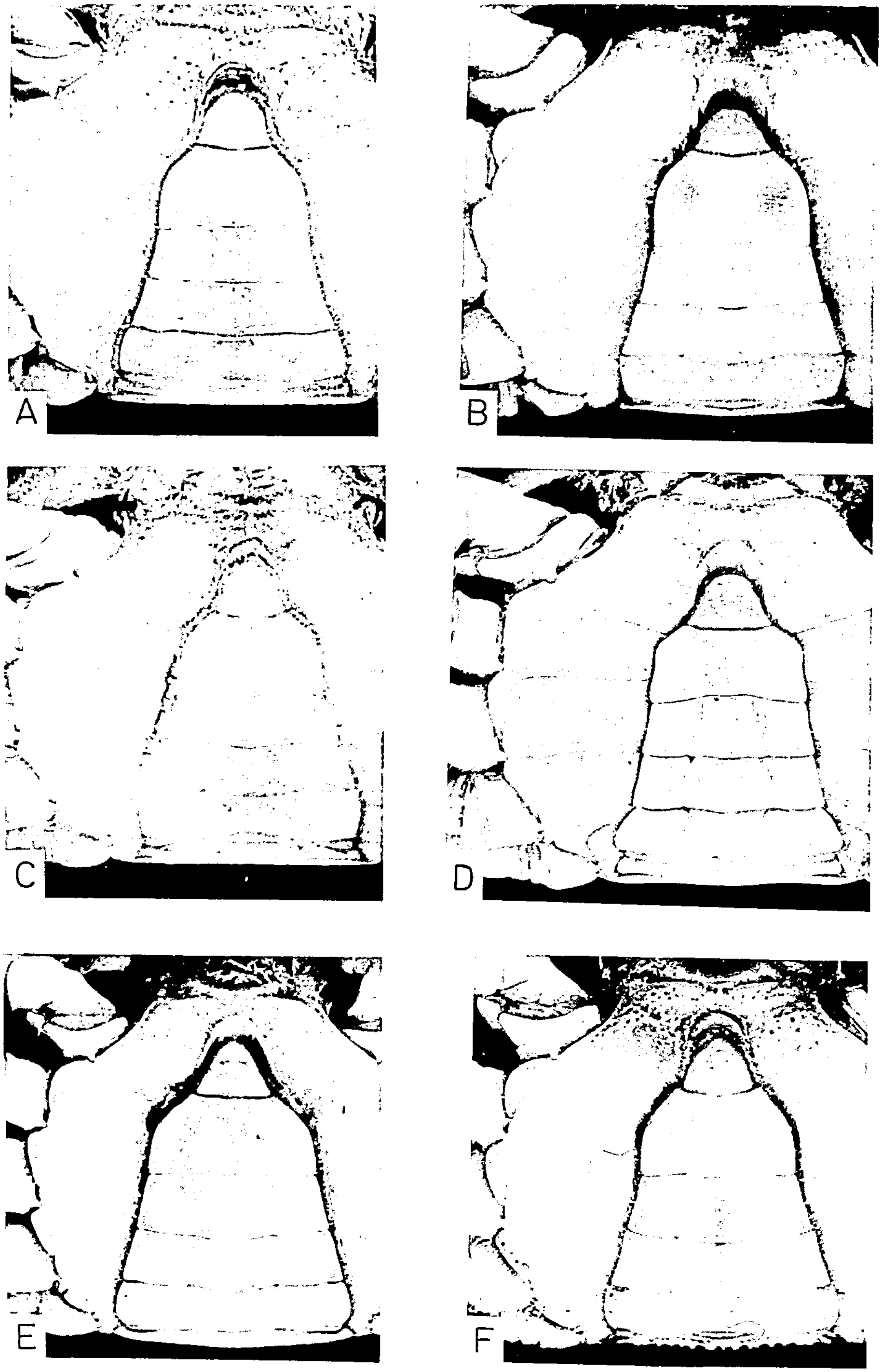
C, Plagusia capensis de Haan.
Male, carapace length 62.8 mm (DM Cr 1223),
Castlepoint, New Zealand.

D, Plagusia dentipes de Haan.
Male, carapace length 45.2 mm (USNM 33234),
Easter I., Pacific Ocean.

(Photographs: Athol Beswick)


A
B
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F

PLATE 7

Male abdomens of Tasmanian sesarminae

A, <u>Cyclograpsus granulosus</u> H. Milne Edwards.
Male, carapace width 27.0 mm (TM G1077),
Sandy Bay Rivulet, Tasmania.

B, <u>Cyclograpsus audouinii</u> H. Milne Edwards.
Male, carapace width 26.0 mm (WAM 203.62),
Woodman's Pt., Western Australia.

C, <u>Cyclograpsus lavauxi</u> H. Milne Edwards.
Male, carapace width 20.0 mm (DM),
Island B., New Zealand.

D, <u>Cyclograpsus punctatus</u> H. Milne Edwards.
Male, carapace width 30.0 mm (SAM), "South Africa".

E, <u>Paragrapsus gaimardii</u> (H. Milne Edwards).
Male, carapace width 36.2 mm (TM),
Norfolk B., Tasmania.

F, <u>Paragrapsus laevis</u> (Dana)
Male, carapace width 31.7 mm (TM),
Prosser R. at Orford, Tasmania.

(Photographs: Athol Beswick)

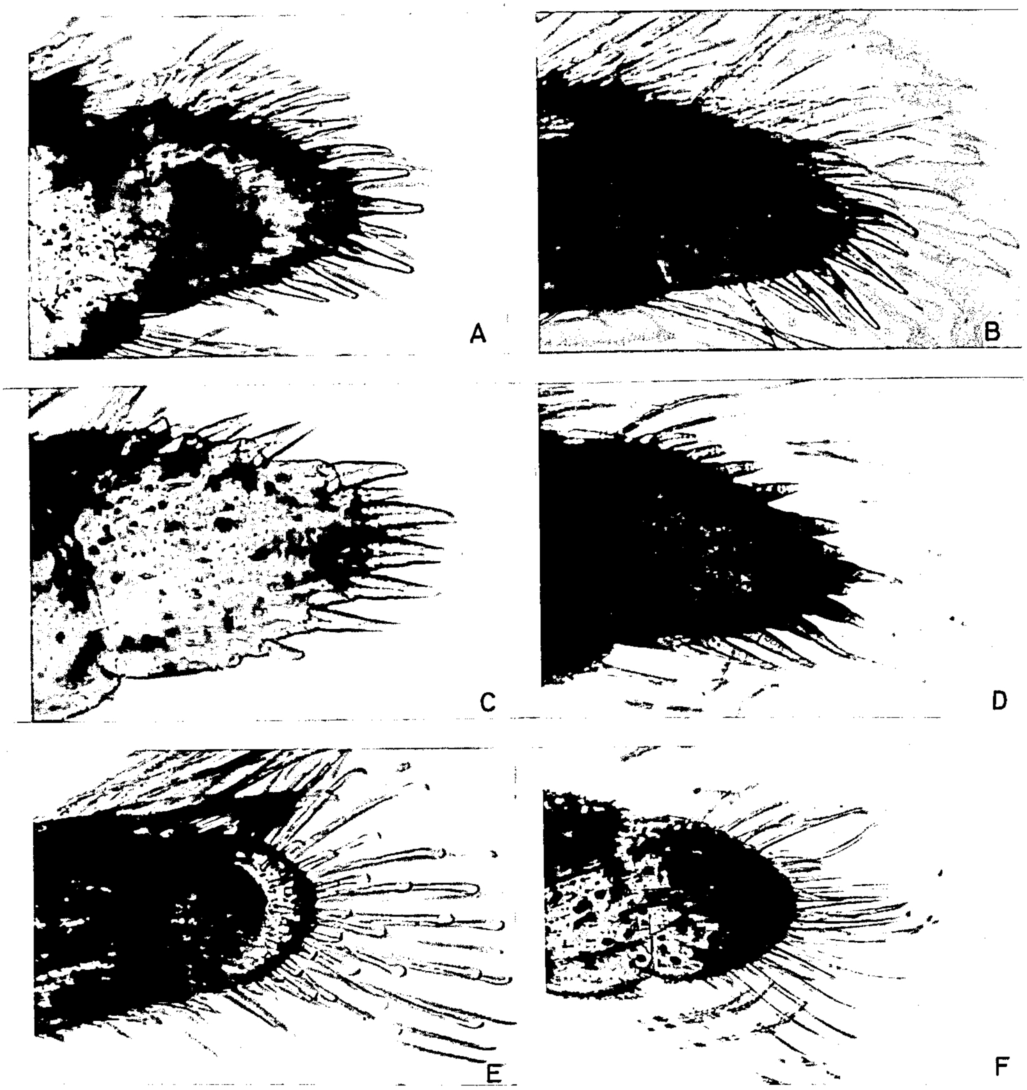

PLATE 8

Tip of palp of second left maxilliped, inner aspect, of six species of Tasmanian grapsids and ocypodids.

A,	Leptograpsodes octodentatus	X 100
B,	Brachynotus spinosus	X 150
C,	Paragrapsus quadridentatus	X 100
D,	Paragrapsus gaimardii	X 70
E,	Heloecius cordiformis	X 100
F,	Hemiplax latifrons	X 100

(Photomicrographs: K.H. Lim and Athol Beswick)

PLATE 9

A, Bicheno

Fully exposed rock platform and boulders. This is the typical habitat of Leptograpsus variegatus which shelters in the numerous horizontal crevices and feeds over the platform and boulders. The infralittoral fringe formed by the strapweed (Durvillea potatorum) is obvious.

B, Prosser River at Orford

Estuary inhabited by Paragrapsus laevis, P. gaimardii, Hemiplax latifrons which live in burrows in the wetter parts of the marsh low down on the shore and Heloecius cordiformis which lives in burrows in the upper marsh where the substrate ranges from only slightly muddy sand to clay. The soldier crab (Myctiris platycheles) lives on the upper shore in burrows in the sandier areas.

(Photographs: D.J.G. Griffin and Athol Beswick).

PLATE 10

A, Pirates Bay

View of the "Tesselated Pavements"

a semi-exposed rock platform.

Plagusia capensis is found in the infralittoral, Paragrapsus quadridentatus is present in the lower midlittoral and Cyclograpsus granulosus in the upper midlittoral under scattered boulders. Leptograpsodes octodentatus is found on the boulder beach fringing the platform in the middle distance.

B, North-West Bay at Howden

View of sandstone platform and scattered remnant pools. This sheltered bay is the habitat of Brachynotus spinosus which is found under stones in the pools. Cyclograpsus granulosus, Paragrapsus quadridentatus and P. gaimardii are found under stones and Hemiplax latifrons lives in burrows in the mud flats in the middle distance.

(Photographs: Athol Beswick)

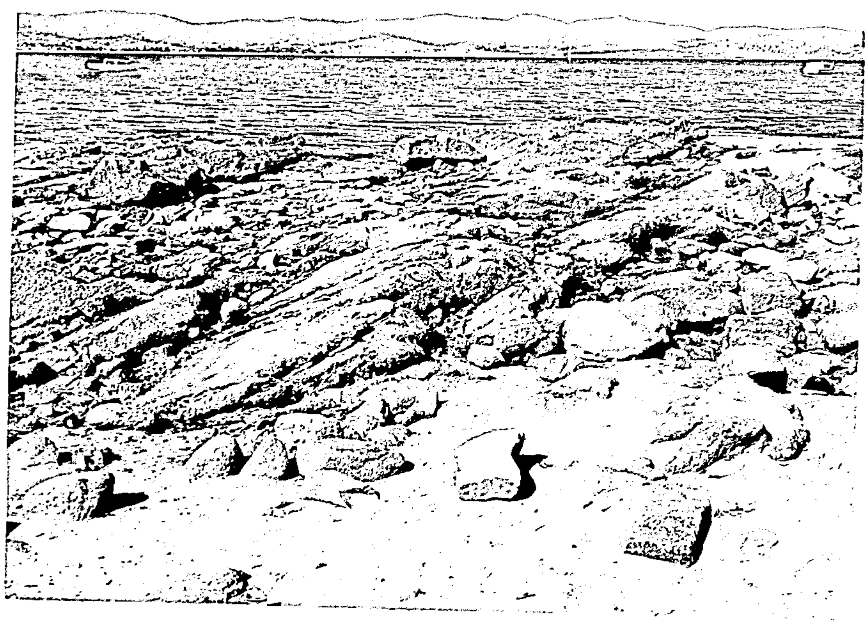

PLATE 11

A, Crayfish Pt., Taroona, River Derwent

A semi-exposed boulder beach, the typical habitat of *Cyclograpsus granulosus* which here extends throughout the midlittoral. The boulders in the lower midlittoral are covered by masses of mussels and tubicolous polychaetes.

B, Sandy Bay, River Derwent

A sheltered boulder and stony beach. *Paragrapsus quadridentatus*, and *P. gaimardii* are found in the lower midlittoral under stones and *Cyclograpsus granulosus* in the upper midlittoral also under stones. *Brachynotus spinosus* is also found here.

The rocks in the lower midlittoral are covered by masses of tubicolous polychaetes (*Galeolaria caespritosa*) and in the upper midlittoral and above by littorinid snails (*Melarapha unifasciata*) and barnacles (*Elminius modestus*).

(Photographs: Athol Beswick)

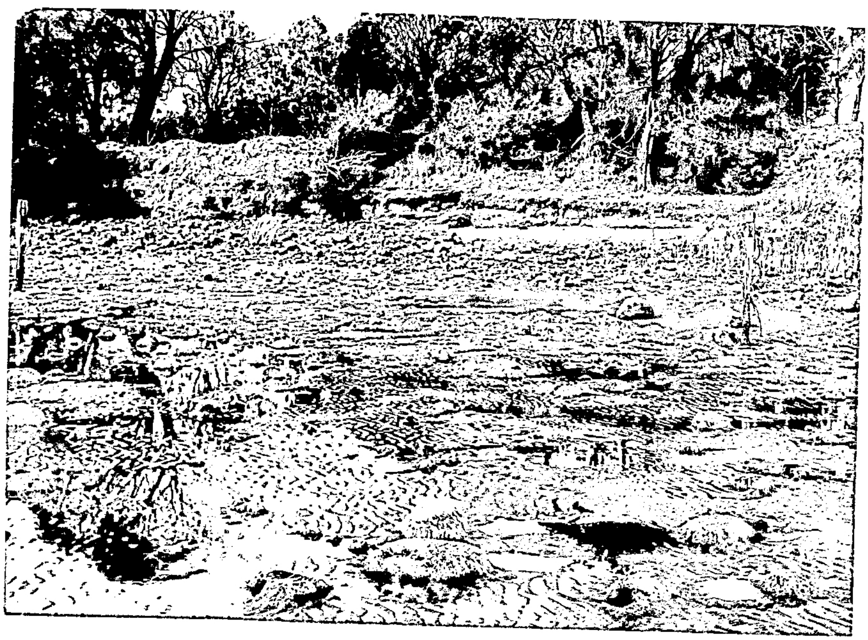

PLATE 12

A, Dunalley Bay

A sheltered boulder beach forming the upper fringe of an extensive sandy estuary. Paragrapsus gaimardii, P. quadridentatus, Cyclograpsus granulosus and Brachynotus spinosus are all found under the boulders.

The lower surfaces of the boulders are covered by masses of tubicolous polychaetes (Galeolaria caespitosa).

The soldier crab (Myctiris platycheles) inhabits the sandy beach in the distance.

B, Elwick Bay, River Derwent.

A sheltered stony beach and sandy muddy estuary. Paragrapsus gaimardii is found under the scattered stones in the lower midlittoral (foreground) and Helograpsus haswellianus under stones in the upper midlittoral and in burrows in the clay bank in the supralittoral.

(Photographs: Athol Beswick)

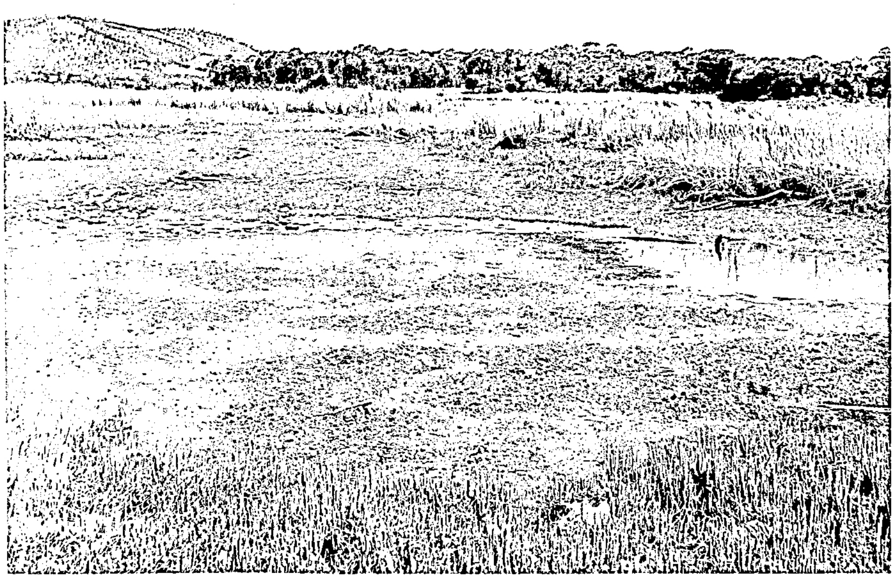

PLATE 13

A, Pittwater

A view from the top of the shore showing the sandstone platform and scattered stones, the typical habitat of Brachynotus spinosus in the upper midlittoral and supralittoral. On the lower shore Paragrapsus gaimardii is found under stones and Hemiplax latifrons and the soldier crabs (Myctiris platycheles) are found in burrows.

B, Margate

A muddy estuary, the typical habitat of the ocypodids, Heloecius cordiformis which lives in burrows in the drier mounds and Hemiplax latifrons which lives in burrows in the wetter runnels and under water. Helograpsus haswellianus is found in the supralittoral in burrows on the bank.

(Photographs: Athol Beswick)

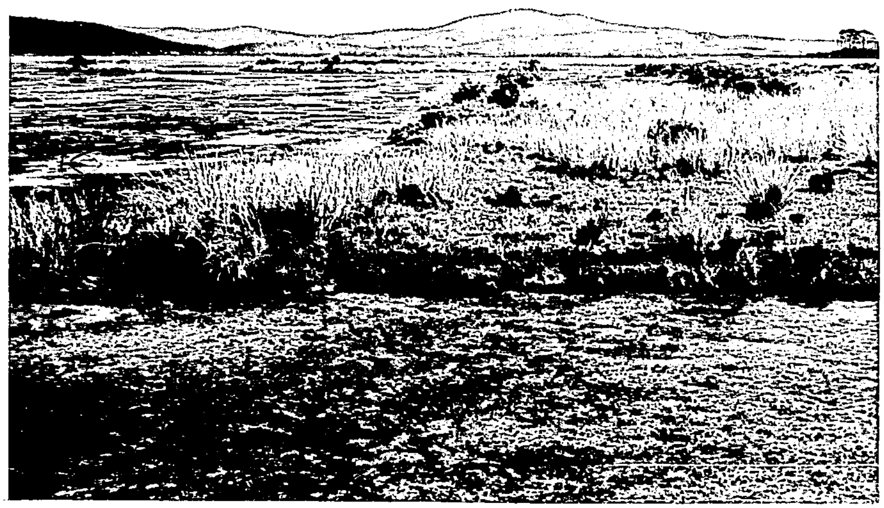

PLATE 14

A, Blackman Bay, mouth of Bream Creek.

Sheltered estuary fringed by a clay bank. *Paragrapsus laevis* is found in deep burrows in the bank and *P. gaimardii* is found in burrows and under stones in the stream bed.

B, Double Creek

View towards the mouth of the creek. *Paragrapsus laevis* and *P. gaimardii* are found under stones throughout the midlittoral. *Heloecius cordiformis* and *Hemiplax latifrons* are found in burrows in the muddy areas free from stones.

(Photographs: D.J.G. Griffin and Athol Beswick).

APPENDIX I STATISTICAL FORMULAE

Linear regressions are calculated by the method of least squares (Bailey, 1959) and are given in the form $y = a + bx$ where y is the dependent, and x the independent, variable; a is the intercept on the y axis and b the regression coefficient. Standard errors of a and b are calculated according to the formulae given by Fisher (1954) and Davies (1957).

Comparison of regressions follows the method given by Simpson and Roe (1937).

Calculation of other statistical estimates mainly follows Bailey (1959).

In the analysis of data on behaviour in relation to fresh water (table 15 and text-figure 42) the variance of the mean was calculated as pq/n (Davies, 1957: 227) where

p = percentage remaining in fresh water

$q = 1 - p$

and n = the number of replicates for each time.

In table 16 the 95% confidence limits of the mean for 50% emigration were calculated as

$$1.96 \frac{s}{b} \sqrt{\frac{1}{m} + \frac{1}{n} + \frac{(y_k - \bar{y})^2}{b\sum(x-\bar{x})(y-\bar{y})}}$$

where s = $\sqrt{\text{mean square about the regression}}$;

b is the regression coefficient;

m is the geometric mean of number of replicates for the whole regression (here taken as 1);

n is the number of paired observations;

and y_k is any particular value of y

(in this case 50%, or 45.00 in angles) (see Davies, 1957: 170-3).

In all these experiments the means are calculated from the pooled results, each replicate being considered to comprise a number of independent concurrent experiments in separate chambers. Calculation of means and regressions takes into account only those crabs remaining in water, those which moved on to the sides of the chamber being excluded.

TABLE I   Values for constants associated with regressions dealt with in the text. The x and y columns give the name of the independent and dependent variables respectively. The a and b columns give the values of a and b (in equation of the form $y = a + bx$) respectively; the second row in these two columns gives the sums of squares due to the regression as a percentage of the total sums of squares (n is the number groups of paired observations used in calculation of the regressions).

Species	Fig.	x	y	a	b	significance (n)
L. variegatus	5A	carapace length	carapace width	-0.60 (0.296)	1.16 (0.017)	99.8 (12)
"	"	"	interorbital width	5.10 (0.274)	0.68 (0.016)	99.4 (12)
"	"	"	anterolateral margin length	1.32 (0.610)	0.52 (0.035)	95.6 (12)
C. granulosus	15A	frontal width	anterolateral margin length	-0.39 (0.076)	0.31 (0.026)	99.3 (10)
C. audouinii	"	"	"	0.20 (0.117)	0.32 (0.046)	98.3 (9)
P. capensis	21	carapace length	carapace width (spine 3)	0.63 (0.149)	1.06 (0.080)	99.9 (13)

Table I, continued.

Species	Fig.	x	y	a	b	significance (n)
P. capensis	21	carapace length	carapace width (spine 2)	0.59 (0.179)	0.97 (0.096)	99.9 (13)
"	"	"	carapace width (spine 1)	2.99 (0.185)	0.79 (0.099)	99.8 (13)
"	"	"	interorbital width	4.46 (0.308)	0.54 (0.164)	99.0 (13)
"	"	" "	frontal width	1.25 (0.011)	0.20 (0.057)	98.9 (13)
"	22B	carapace length	number of spines on b. ant. art.	1.06 (0.178)	0.04 (0.009)	61.5 (13)
"	23A	"	number of spines on ant. b. mth.	10.08 (0.343)	-0.02 (0.018)	13.5 (13)
" (juveniles)	22B	"	number of spines on s. orb. b.	42.35 (0.037)	-1.55 (0.398)	80.3 (3)

Table 1, continued.

Species	Fig.	x	y	a	b	significance (n)
P. capensis (adults)	23B	carapace length	number of spines on s. orb. b.	12.68 (1.626)	-0.07 (0.003)	93.8 (9)
P. capensis	24	length ambulatory merus 3	number of dorsal spines	4.85 (0.511)	0.18 (0.039)	75.1 (9)
H. cordiformis	42	log. time	% remaining in f.w.	93.92 (1.62)	-24.97 (3.90)	89.1 (7)
L. octodentatus	"	"	"	65.68 (1.10)	-14.26 (2.65)	85.2 (7)
H. haswellianus	"	"	"	95.67 (2.13)	-37.07 (5.15)	91.3 (7)
P. gaimardii	"	"	"	78.78 (1.57)	-29.89 (3.79)	92.6 (7)
H. latifrons	"	"	"	66.04 (1.16)	-28.62 (3.40)	94.7 (6)

Table 1, continued.

Species	Fig.	x	y	a	b	significance (n)
C. granulosus	42	log. time	% remaining in f.w.	65.64 (3.35)	-30.12 (12.58)	63.50 (5)
BB. spinosusq	"	"	"	66.98 (2.09)	-35.02 (7.84)	86.90 (5)
P. quadridentatus	"	"	"	64.57 (1.71)	-35.45 (6.44)	75.60 (5)

The published papers forming appendix II and supporting papers 1 - 3 are located together at the end of this thesis.

Supporting paper number 4

"A Review of the Australian Majid Spider Crabs
(Crustacea, Brachyura)."

The manuscript which follows was submitted for publication in the Australian Zoologist in September, 1965.

A REVIEW OF THE AUSTRALIAN MAJID SPIDER CRABS (CRUSTACEA, BRACHYURA)

SUMMARY

An historical account is given of taxonomic studies of spider or masking crabs in Australia and overseas. The basis of the review is a key to all but two of the species known to occur in Australia. The key includes information on synonymies, geographic and bathymetric distribution and references to descriptions and illustrations of the species. Characters which are important in the classification are briefly reviewed. Zoogeographical relationships of the fauna are discussed.

The family Majidae is currently divided into seven subfamilies mainly on the basis of orbital configuration, form of the rostrum, abdomen and first pleopod of the male. All but one of the subfamilies are represented in the Australian fauna which is considered to comprise 95 species in 45 genera. This is about twice the number of species and genera listed by Haswell (1882c) in his "Catalogue". About one-third of the species have been recorded from Australia on only a single occasion. Numerous genera and species are in need of detailed reinvestigation.

The fauna is rather clearly partitioned into a tropical group with widespread Indo-West-Pacific relationships and a temperate group related to tropical Australia and/or the Indo-West-Pacific rather than to temperate regions outside Australia. There are no clear boundaries between these two faunas but rather quite broad transition areas. Thirty-seven species and five genera, most of which are temperate, are restricted to Australia.

I. INTRODUCTION

One of the most characteristic features of spider crabs of the family Majidae is the presence on the carapace and legs of special curled or 'hooked' hairs which aid in the attachment of various kinds of epifauna and flora, especially seaweeds (for example see McNeill 1923). These organisms are placed in position by the crab with the aid of the chelipeds which are able to reach up on to the dorsal surface of the carapace. For this reason majid crabs are sometimes called "masking crabs" or "seaweed crabs". Of special interest in these crabs are the orbits which may be expanded in various ways and surrounded by a seemingly complex array of spines. The legs are often long and slender and the carapace usually triangular or pyriform. Spider crabs range in size from a few millimetres to more than a metre in carapace length and are found in almost all seas and oceans. They form a relatively important part of the benthos and may be locally very abundant on the shelf although some species extend considerable distances down the continental slope to depths as great as 1000 fathoms.

Substantial revisions of the family Majidae have been undertaken on a world-wide scale by Dana (1851), Miers (1879a), Alcock (1895) and Balss (1929). Sakai (1938), Stephensen (1945) and Garth (1958) have adapted Balss's scheme to the faunas of Japan, the Iranian Gulf and America respectively. In the course of these revisions the Majidae have been arranged in several very different fashions (see historical reviews by Miers (1879a) and Garth (1958)). Early workers such as Dana and Miers grouped the species in several families and a large number of subfamilies - Dana's arrangement comprised five families and

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revisions to contain the species in a single family. This was divided into four subfamilies and seven "alliances". Whereas revisors before Balss had proceeded by rearrangement of previous schemes, Alcock's groups of genera were left almost untouched by Balss, his alliances in some cases being elevated to subfamilial rank as much as they were conceived. The number of subfamilies currently recognised stands at seven following the work of Garth.

Many morphological characters have been used in these different classifications and some have been shown to be unreliable guides to phylogenetic relationships (see Section III). Characters concerned with the form of the orbit still dominate the classification but Garth has found, in the Pacific American fauna, groups of genera showing vast agreements in the form of the male first pleopod. This appendage is now realized to be of great value in the taxonomy of nearly all families of crabs.

The first Australian spider crabs to be described were made known by the European naturalists Herbst, Latreille and H. Milne Edwards in the early nineteenth century. In the second half of that century the work of Dana, Stimpson, Miers and Haswell resulted in substantial additions to knowledge of the Australian spider crab fauna. Dana in 1852 dealt with the Crustacea of the U.S. Exploring Expedition of 1838 – 42, Stimpson with the Crustacea of the North Pacific Exploring Expedition led by Ringgold and Rodgers (Stimpson (1857) - full report not published until 1907). Haswell published six papers between 1879 and 1882 and in 1882 (Haswell 1882c) provided the first list of all species known from Australia. But Miers's important reports on the material collected by the "Alert" in 1881-2 (Miers 1884) and by the "Challenger" in 1873-76 (Miers 1886) outdated Haswell's list to some extent. So too did the reports of W.T. Calman (1900) and A. Ortmann (1894) on collections of Brachyura from Torres Strait.

Haswell's work at the Australian Museum was followed by that of Thomas Whitelegge whose report on the Crustacea collected off eastern Australia by the "Thetis" (Whitelegge 1900) may be particularly mentioned. W.H. Baker (1905, 1906) dealt with South Australian Brachyura and S.W. Fulton, F.E. Grant and Alan R. McCulloch all paid some attention to south-eastern Australian species in the first and second decades of the present century. In the 1920's Herbert M. Hale (1924, 1927, 1929) reported on southern and western species. The numerous reports, from the 1890's to the 1920's, by Mary J. Rathbun of the Smithsonian Institution at the same time added several species to the Australian lists and extended the known ranges of many others; two reports (Rathbun 1914;1924) dealt with collections from western Australia. S.K. Montgomery's report on the Brachyura of the Percy Sladden Trust Expedition to the Abrolhos (Montgomery 1931) and Dr. Heinrich Balss's paper (1935) on the material collected by the Hamburg Museum's Expedition to south-western Australia in 1905 are the latest sources of information on western spider crabs. The contemporary and later work of Frank A. McNeill and Melbourne Ward, both at the Australian Museum, dealt mainly with north-eastern species.

The present situation with regard to the Australian majid spider crab fauna is thus as follows. No revisionary treatment has ever been attempted and no comprehensive guide has appeared since the time of

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Haswell. Until recently only McCulloch (1908, 1913) had completed revisions at the generic level. Nearly all reports dealing with majids have merely added species or extended known geographic ranges. The most important recent references to Australian species are those primarily treating overseas faunas (e.g. Sakai 1938, 1965; Buitendijk 1939; Barnard 1950; and Forest & Guinot 1961). The number of known valid genera and species has doubled since the time of Haswell and collections have continued to accumulate at various museums, particularly the Australian Museum, Sydney and the Western Australian Museum, Perth. Several areas of the Australian coastline remain uninvestigated, particularly that west of Torres Strait south to Broome and most of the Great Australian Bight. The Australian Museum possesses a fine catalogue of all described genera and species. Not the least important of the many problems which therefore remain unanswered is the question of whether the Australian genera can be grouped, on the basis of the male first pleopods (unknown in the vast majority of local species), in an arrangement which parallels that found by Garth.

The present paper attempts to bring together available information on the Australian Brachyura of the family Majidae. This information is presented in the form of a key to genera and species with distributional and other information included. The following discussions centre around this key. Current problems are pointed out but there is no intention here of giving a general revision. Adequate treatments of the morphology of members of this family are given by Rathbun (1925), Garth (1958) and Griffin (in press,b). Terminology, unless otherwise indicated, follows that used by Rathbun and Garth and by Griffin in previous papers. Although most information used in the key is taken from the literature, a considerable amount of material comprising most of the species represented in Australia, has been examined at the Australian Museum over the past three years.

II. THE FAMILY

The Majidae belong, with the Hymenosomidae (flat-back crabs) and the Parthenopidae (calthrop crabs), to the superfamily Oxyrhyncha. All three families possess an anteriorly narrowed and produced carapace with prominently expanded branchial regions, large epistome, quadrate buccal cavity and longitudinally folded antennules. The characters which chiefly distinguish majid crabs from other families of the Brachyura are 1) the possession of specially mobile chelipeds; 2) fusion of the well-developed second article of the antenna (usually called the basal antennal article) to the epistome and often also to the front; 3) the comparatively incomplete orbits; 4) articulation of the palp of the external maxillipeds at the anteromedial angle of the merus; and 5) the much greater length of the first pleopods of the male relative to the second pair. The family has usually been considered in the past to share with other Oxyrhyncha nine pairs of gills on each side but Hartnoll (1964) has recently shown that this number is sometimes reduced in the Majidae to seven or eight.

It should be mentioned that the term Maioidea used by Dana and Miers is partially synonymous with Oxyrhyncha (as now understood) and not with the term Majidae (until recently frequently spelt Maiidae). In Dana's and Miers's time the Maioidea included only the Majidae and the Parthenopidae; de Haan's (1839) addition of the Hymenosomidae did not gain general acceptance until after Rathbun (1925).

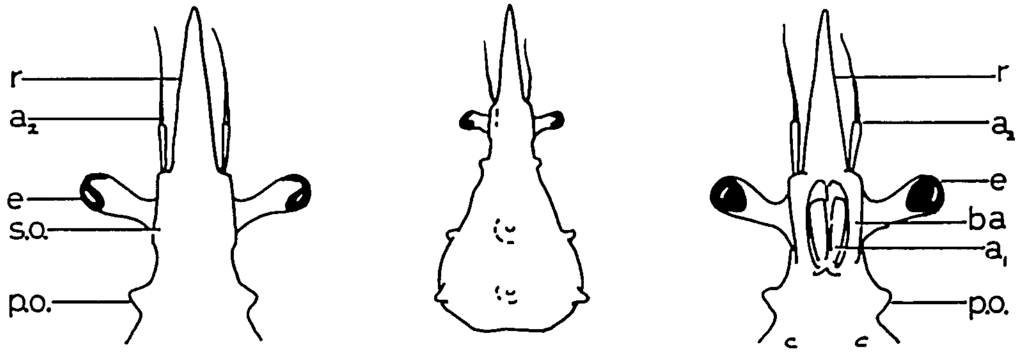
As to the evolution and relationships of the Oxyrhyncha, Glaessner (1960:46) states, "The Oxyrhyncha, or spider crabs, are ... unrepresented before the Tertiary except by unidentifiable fragments. The pointed rostrum ... and the prominent mesogastral-cardiac ridge, together with the elongate cephalothorax, place this group much closer to the Oxystomata than to the Brachyrhyncha, but it is more advanced in the organization of its mouthparts."

III. THE SUBFAMILIES

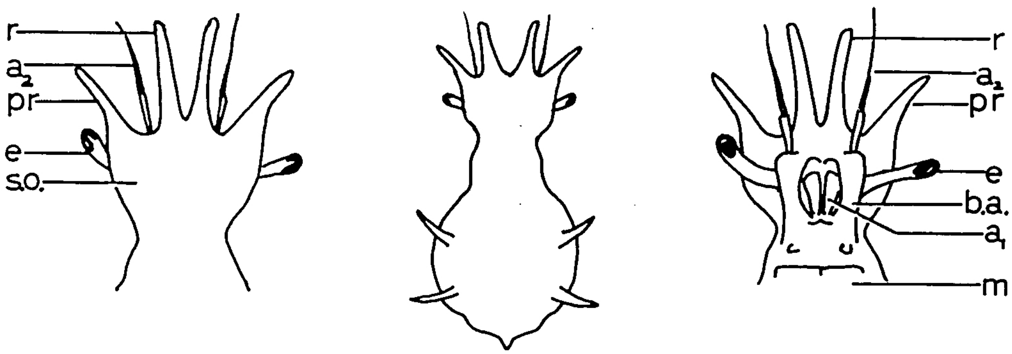
The subfamilial arrangement adopted here is that proposed by Garth (1958) which is a modification of the schemes of Alcock (1895) and Balss (1929). In the delimitation of subfamilies and in the arrangement of genera within them particular attention has been paid to the structure of the orbit, i.e., the degree of expansion of the anterolateral part of the carapace above the origin of the eyestalk (the "supraorbital eave"), the presence or absence, and form of, a spine behind the eave (the "postorbital spine") and the degree of expansion of the basal antennal article. These are characters used before Alcock by Miers (1879c) and to some extent by Dana (1851). H. Milne Edwards (1834) considered the length of the ambulatory legs to be important and the classification proposed by de Haan (1839) was based on the shape of the merus of the third maxillipeds. Use of these latter characters was criticised by Miers. In 1861 Claus proposed a classification based on the form of the basal antennal article. Use of this character was criticised by Stimpson in 1871. Balss laid particular stress on a further feature associated with the structure of the orbit: the presence or absence of a spine (the "intercalated spine") between the eave and the postorbital lobe. However, later workers on the group (Sakai 1938 and Garth 1958) have considered that Balss laid too much stress on this feature (see below). The relative size of this spine is sometimes variable with either growth or geographical locality (Garth 1958; Griffin, unpublished). Balss also introduced three other characters: the number of free segments of the abdomen(basically seven but sometimes reduced by coalescence or fusion involving segments four to six inclusive), the degree of development of the interantennular spine (the true rostrum of the zoea) and the degree of fusion of the (pseudo) rostral spines.

In the key presented here genera within each subfamily are arranged in a series which begins with forms with a double rostrum and seven free abdominal segments in both sexes and ends with those in which the rostral spines are partly or wholly fused and the number of free segments in the abdomen is reduced. In this respect the key resembles those provided by Garth (1958). Implicit in such a presentation is the concept that parallel evolution has proceeded independently within each subfamily. The genera at the beginnong of the series are considered to be primitive and those at the end advanced. This is in accordance with the ideas of Balss who considered that a well developed interantennular spine and the presence of an intercalated spine were also primitive features.

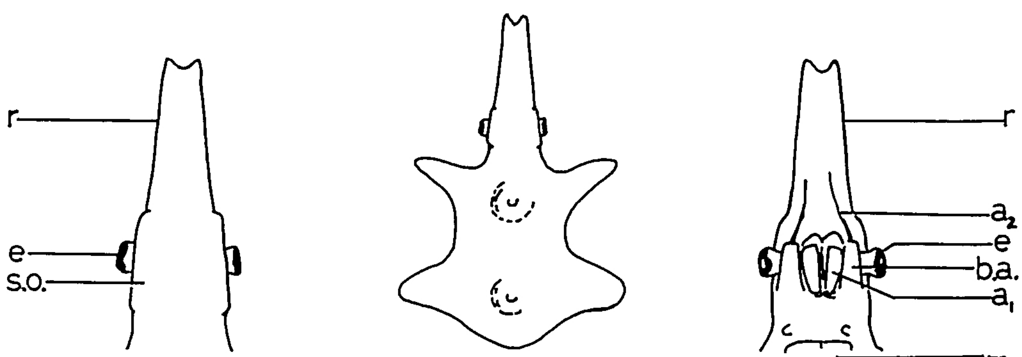
Some aspects of orbital structure require further clarification. The term "commencing orbit", used in respect of some of the Opthalmiinae, Acanthonychinae and Pisinae, is intended to contrast with the unformed orbits of the Inachinae and some members of the Acanthonychinae on the one hand and with the complete or almost complete orbits of the Majinae and Mithracinae on the other. The commencing orbit is thus intermediate



INACHINAE



OPHTHALMIINAE



ACANTHONYCHINAE

TEXT-FIG. 1 Generalized morphology of the subfamilies Inachinae, Ophthalmiinae and Acanthonychinae. Front of the carapace from above at left and from below at right; whole carapace from above in the middle. Abbreviations: a_1, antennule; a_2, antenna; a.o., antorbital spine; b.a., basal antennal article; e, eye; m, mouthfield; p.o., postorbital lobe; pr, preorbital spine; r, rostrum; s.o., supraorbital eave.

between two extremes. It involves partial enlargement of the supra-orbital cave, most commonly by the development of a prominent spine either anteriorly or, less often, posteriorly; this spine scarcely conceals the eyestalk from dorsal view.

In some inachines there is above the origin of the eyestalk a variously developed spine, considered by Balss to represent the intercalated spine. However, in the Inachinae, this spine is very seldom separated by distinct fissures from the surrounding parts of the orbit as it is in the Majinae and some Mithracinae. Further, in some inachine genera which appear to be natural groups, some species possess a spine above the eyestalk and some do not. It would seem better to call this spine merely a supraorbital spine and to disregard, at least for the present, any possible homology between it in the Inachinae and the intercalated spine of other majids.

A similar difficulty exists in many of the Pisinae. In some the postorbital lobe is provided on the upper anterior edge close to the base with a prominent accessory lobe and in a few species this lobe is quite distinct from the postorbital lobe. In other pisines where the cave is virtually unexpanded a small denticle is present on the supraorbital margin. There this lobe or denticle appears to be the intercalated spine and is generally so treated here.

To sum up, emphasis on the intercalated spine led Balss to divide the Inachinae and the Pisinae each into two further subfamilies. In at least the Inachinae it is difficult to work out the homologies of a spine above the orbit in those species in which it is present and in the Pisinae Garth has found that such a division, in the Pacific American forms, is not supported by the male first pleopods. The term supraorbital spine is used, especially in the Inachinae,. to denote a spine above the orbit where homologies are not clear. In other groups the term preorbital spine is restricted to mean an anterior outgrowth of the supraorbital eave and the term antorbital spine is used to denote a posterior outgrowth (see figure in Griffin, in press, a).

The characters of the six subfamilies represented in Australia are now given (the number of the couplet in the key at which genera of each subfamily begin is indicated in brackets after the name):

INACHINAE (4): Orbits undeveloped, or eave weakly expanded only; a supraorbital spine sometimes present. A postorbital spine sometimes present but affording no concealment to the cornea of the retracted eyestalk. Basal antennal article extremely slender and usually long. Eyestalk very long and visible almost to its base in both dorsal and ventral view. Carapace subtriangular or sometimes subpyriform or occasionally circular. Rostrum sometimes of a single spine, and frequently short. Ambulatory legs frequently extremely long and slender.

OPTHALMIINAE (26): Orbits consisting of a well developed and laterally expanded eave or of a greatly elongated spine. Postorbital spine short. An intercalated spine never present. Basal antennal article moderately expanded only. Eyestalk very long, often concealed in dorsal view but always largely visible in ventral view. Carapace elongate and often truncate in front and provided with a medial expansion or spine posteriorly. Rostral spines distinct and usually short. Ambulatory legs seldom very long.

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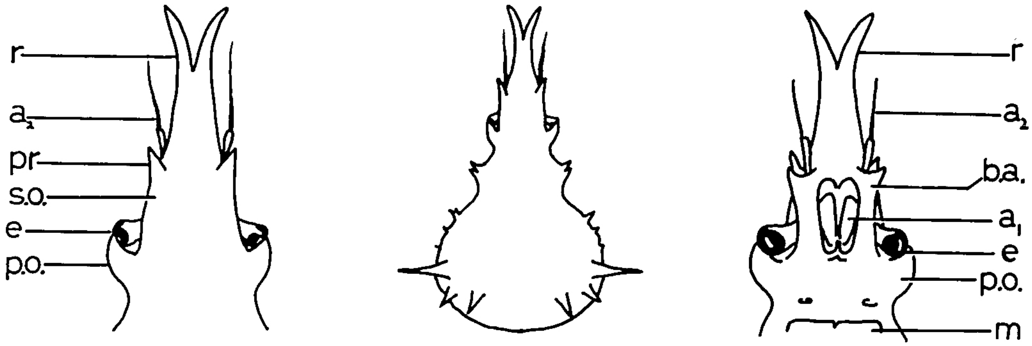
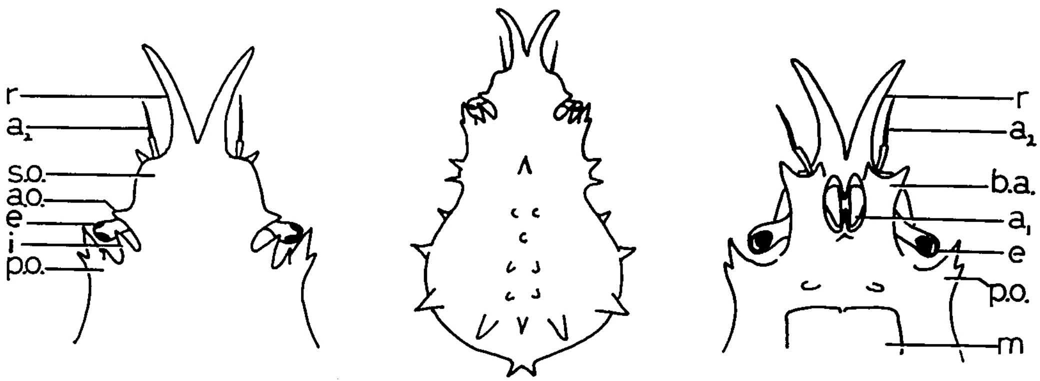
ACANTHONYCHINAE (29): Orbits undeveloped, eave rounded or forwardly produced as a preorbital spine. Postorbital spine, if present, simple and affording no concealment to eyestalk. Basal antennal article not very wide and characteristically truncate triangular. Eyestalks extremely short and often sunk in sides of rostrum. Carapace basically pyriform but characteristically twice expanded laterally at hepatic and branchial margins. Rostrum consisting either of two distinct spines or sometimes of a huge "beak". Ambulatory legs short or at most of moderate length.

PISINAE (36): Orbits with a weakly expanded eave either produced anteriorly as a preorbital spine or acute or sometimes posteriorly acute, or else weakly expanded midway along and almost confluent with the postorbital lobe. Intercalated spine present or absent, sometimes a small denticle or lobe close to the postorbital lobe. Postorbital lobe always well developed and cupped but not completely concealing the eyestalk from dorsal view. Basal antennal article slightly to broadly expanded and usually produced into a spine anterolaterally. Eyestalk typically short and bulbous with a large cornea. Carapace always pyriform although sometimes very wide. Rostrum frequently bifid for distal half only. Ambulatory legs often very long and slender.

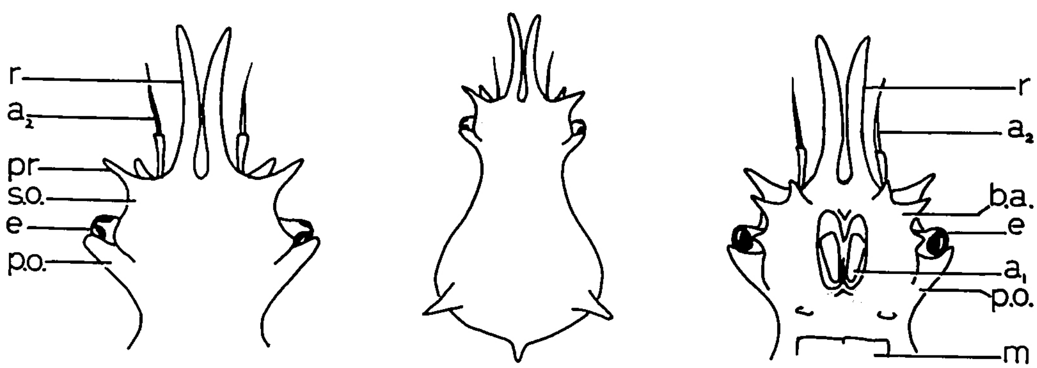
MAJINAE (62): Orbit well developed, comprising above a laterally expanded eave which is always acute posteriorly and sometimes produced into a spine, an intercalated spine and a postorbital spine which is sometimes simple and sometimes cupped and occasionally armed with an accessory spine on the upper anterior edge near the base. Basal antennal article moderately broad and rectangular and frequently armed with spines at both anteromedial and anterolateral angles. Eyestalks of moderate length



PISINAE



MAJINAE



MITHRACINAE

TEXT-FIG. 2 Generalized morphology of the subfamilies Pisinae, Majinae and Mithracinae. Arrangement and abbreviations as in text-fig. 1.

and generally slender; only the distal half is visible in dorsal view. Carapace pyriform and sometimes broad. Rostrum always of two distinct spines. Ambulatory legs generally of moderate length.

MITHRACINAE (81): Orbits extremely well developed with the eave and basal antennal article laterally expanded and usually tubular, completed behind by the prominent postorbital lobe which is often cupped. An intercalated spine is sometimes present. Eave sometimes forwardly produced into a preorbital spine or lobe, and sometimes prolonged posteriorly into an antorbital spine. Eyestalk moderately long but only the distal portion generally visible in either dorsal or ventral view. Carapace basically pyriform but anteriorly broadened due to expansion of orbits. Rostrum of two distinct spines which are often contiguous and sometimes fused into a broad lamella. Ambulatory legs seldom of great length.

The seventh subfamily, the OREGONIINAE, contains three genera which are boreal in distribution and not represented in Australia. They resemble the Inachinae in most features but are characterized by the terminally broadened male abdomen, the seventh segment being quadrate and deeply inserted into the sixth segment, and the longitudinally grooved male first pleopod, the groove being margined by rows of filamentous setae. A detailed treatment is given by Garth (1958).

IV. THE GENERA

The characters which are of value at the generic level are essentially the same as those used at the subfamilial level and already discussed. It need only be emphasized that the application of these characters at the generic level is invariably more rigorous than at the higher levels. Thus congeneric species are usually considered to share very similar orbital structure, form of the rostrum and of the male first pleopods and to agree in the number of free segments in the abdomen. They also generally resemble each other closely in carapace shape and ornamentation, form of the third maxillipeds, shape of the male abdomen (a character introduced by Shen in 1932) and often shape of the male chela but seldom in actual size and in relative length of the ambulatory legs.

The remaining part of this section and most of the succeeding one will be devoted to a discussion of the several lower taxa of the Australian Majidae which are considered to pose important problems at the present time.

Of the 24 majid genera listed by Haswell (1882c), ten now either have quite different meanings or are known under different names. These are as follows:

1. Stenorhynchus Lamarck. Of the three species included here by Haswell two have been shifted to Achaeus and one, S. curvirostris, has not been collected since its discovery (see next section). Lamarck's genus is currently recognized for two species confined to the Americas (Garth 1958, Garth & Holthuis 1963); since Haswell mentions the rostrum being formed of two spines, not one, it is reasonable to assume that he intended to refer to Stenorhynchus Latreille (now considered a synonym of Macropodia Leach, 1814).

2. Halimus Latreille. The species included here by Haswell are now known as species of Naxia Latreille, Halimus being a junior synonym of that genus. The composition of the abdomen (of both sexes) and of several other characters in these species requires investigation to

determine its relationships to the New Zealand representative of the genus (see Griffin, in press). The comparatively well developed orbits and distally expanded ambulatory propodi set this genus apart from other inachines. Haswell's subgenus Microhalimus, with its single species, M. deflexifrons, was included as a subgenus of Naxia by McCulloch (1908). For the sake of convenience, Microhalimus is here not given subgeneric status though it is true that M. deflexifrons appears to differ in some important features of the orbit from other species of Naxia, particularly in the number and arrangement of the spines above and behind the orbit. Such disagreement is especially obvious when it is compared with those species with which it agrees in the slight expansion of the ambulatory propodi.

3. Naxia H. Milne Edwards. Haswell listed one species under this genus, Pisa serculifer Guérin. This was transferred to Naxioides A. Milne Edwards (of which Naxia Miers is a synonym) by Rathbun (1914) and later (Rathbun 1924) set apart in a genus of its own, Paranaxia; H. Milne Edwards's genus is a synonym of the latter.

4-6. Gonatorhynchus Haswell, Paramithrax H. Milne Edwards and Chlorinoides Haswell. Gonatorhynchus has recently (Griffin 1963b) been sunk in Paramithrax which has been recognised as monotypic. There appear to be some important similarities in orbital structure between P. barbicornis and Anacinetops stimpsoni although the species are at present placed in different subfamilies. The meaning attributed Paramithrax in Haswell's time has also been changed through the removal of several species to Chlorinoides (see Griffin, in press a). These latter species are the ones often placed in Acanthophrys A. Milne Edwards, a genus synonymous with Hyastenus White.

7 - 9. Egeria Latreille, Cyclomaia Stimpson and Parathoe Miers. These have been replaced respectively by Phalangipus Latreille, Cyclax H. Milne Edwards and Perinia Dana without change in meaning. In addition Eucinetops Stimpson no longer appears in the Australian lists, Anacinetops Miers having been accepted for E. stimpsoni Miers (see Balss 1935). One genus listed by Haswell among the Oxyrhyncha, the monotypic Pleurophricus A. Milne Edwards, has recently been included among the Cymopolidae (now known as the Palicidae - see Holthuis 1962: 244, 249) by Balss (1957: 1662) and is not treated here.

10. Chorilibinia Lockington. This genus was listed by Haswell under the name Chlorolibinia; it will be discussed in more detail at the end of this section.

A nomenclatural point which should be mentioned here concerns the genus Camposcia. Balss (1957: 1620) lists this as Camposcia Desmarest, 1823. Yaldwyn (pers. comm.) has kindly informed me that Desmarest's reference (Dict. Sci. nat. 28: 259,262) is to an MS name of Leach, Camposia. Other authors before Latreille (1829) (in Cuvier's Reg. Anim. IV.(2):60) also used this spelling. However, it appears that Latreille who used the name Camposcia, was the first to include a species in the genus. Camposia of Desmarest and others would, therefore, appear to be a 'nomen nudem'. The species included in Camposcia Latreille, 1829 was C. retuja which was listed without comment by H. Milne Edwards (1834:283) as Camposcia retusa Latreille, 1829. All subsequent workers used these spellings which are therefore followed here.

Among other genera which need re-examination in regard to their distinctness and relationships are Xenocarcinus, Zewa, Phalangipus, Doclea, Antilibinia, Hyastenus and Micippa.

1. Xenocarcinus White. Sakai (1938:324) has placed this genus in the subfamily currently known as the Mithracinae because he considers that at least two of the Japanese species show traces of an intercalated spine. Although this structure is unknown in the Acanthonychinae, Xenocarcinus is here placed in that subfamily because of its numerous resemblances to other acanthonychinines.

2. Zewa McCulloch. This genus was introduced in 1913 for a (new) species from north-eastern Australia. At the same time the earlier described Pseudomicippe varians Miers was included because, as McCulloch noted, previous workers had expressed some doubts about the wisdom of considering this latter species to be congeneric with P. tenuipes A. Milne Edwards. McCulloch considered the presence of a large lobe above the orbit and of a spine on the posterior border of the carapace important characters in this genus. Balss (1957), however, lists Zewa as a synonym of Pseudomicippe Heller. Although comparisons of descriptions and figures of the three species (see Buitendijk 1939: 255, pl. VIII figs. 3 & 4; and Sankarankutty 1962: 160, figs. 17-23 for P. tenuipes) certainly inclines me towards Balss's view, I retain McCulloch's genus pending a fuller investigation of the Australian species.

3. Phalangipus Latreille and Doclea Leach. These two genera are among those pisines in which positive identification of an intercalated spine is difficult. In both genera the eave is poorly expanded and separated by a more or less wide hiatus from the postorbital lobe.

Phalangipus is usually regarded as possessing an intercalated spine and *Doclea* to be lacking it. Thus *P. australiensis*, which possesses a small denticle in the hiatus, is widely separated in the key from *D. profunda*, in which there is no denticle. But among species of *Doclea*, the South African *D. muricata* (Herbst) (see Barnard 1950: 49, fig. 11a) does possess such a denticle just forward of the postorbital lobe. Some rearrangement of species may be necessary. Rather striking differences in carapace shape exist between the species of *Doclea* (see Sakai 1938: pl. XXXVII) just as in *Naxioides*.

4. *Antilibinia* Macleay. Three species are at present included in this genus, one each from South Africa, the Philippines and Australia. The last two were both described by Rathbun from a few specimens and have not been since discussed on the basis of additional material. Barnard (1950:37) doubted that the Australian *A. lappacea* belongs in the same genus as the South African *A. smithii* because of differences in carapace shape and length of the rostrum; he also considered that the latter species might well be shifted to the American *Taliepus* A. Milne Edwards, again because of similarities in carapace shape. Indeed both *Antilibinia* and *Taliepus* have in the past been considered subgenera of *Epialtus* H. Milne Edwards (see Garth 1958:207). A new genus may be required for the Australian and Philippine species.

5. *Hyastenus* White. As the basis for Balss's (1929) Hyasteninae, this extremely large genus (Balss in 1935 listed 38 species) is usually considered to be characterised especially by an absence of an intercalated spine from the orbit and by the distinctness of all seven abdominal segments. However, Laurie (1906) has noted that in his *H. irami* there

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is a distinct lobe between the eave and postorbital lobe. H. convexus Miers also appears to possess such a structure and many species of Hyastenus have on the upper anterior edge of the postorbital lobe a well developed accessory lobe. Sakai (1938:280) has pointed out that the abdomen of the female of H. diacanthus (de Haan) consists of only five segments. Such features are usually considered sufficient to warrant generic separation.

6. Micippa Leach and Paramicippa H. Milne Edwards. When Paramicippa was first set up in 1834, two species, Micippa platipes Ruppell and P. tuberculosa Milne Edwards were included. The first was designated type species of Paramicippa by Miers (1879c: 662) and a definition of that genus given at the same time. The second species was alone included in Paramicippa in Miers's later revision of the two genera (Miers 1885). Such a procedure was quite invalid. Since M. platipes is now generally accepted as belonging to Micippa (Sakai 1938, Buitendijk 1939), Paramicippa should fall to that genus. If a separate genus is to be established for P. tuberculosa because of the pronounced bifid nature of its rostrum or its comparatively long eyestalks or for any other reason, a new name must be used. The situationawaits further investigation and P. tuberculosa is here included amongst species of Micippa.

Finally, among the genera introduced to the Australian lists in this paper, two require further mention; in one way they may be regarded as merely replacing names already in use.

1. Scyramathia A. Milne Edwards. In 1918 Rathbun placed Hyastenus fultoni Grant, 1905 in this genus which has recently been recognised as

a synonym of *Rochinia* A. Milne Edwards (Garth 1958:282). Examination of material of Grant's species (11 specimens including relatively large males and females from the Australian Museum's collections: reg. no. P.4515, 20 miles east of Babel I., Tasmania, 65-70 fms., "Endeavour" Expedition) reveals the male first pleopod as being of the "pisoidiform" type (Garth 1958:249; see also his pl. Q) with a truncate but poorly expanded apex and similar to that of *Rochinia occidentalis* (Faxon) (see Garth 1958: pl. Q fig. 7). *H. fultoni* also resembles this species in shape and type of ornamentation of the carapace, relative length of the rostrum, form of the orbit and in several other features (see Rathbun 1925: pls. 228, 229 fig. 5). It seems to fit very satisfactorily into *Rochinia* which genus is now added to the Australian fauna. In the Indo-West-Pacific, species of *Rochinia* are known also from Japan, India and South Africa.

2. *Chorilibinia* Lockington. Garth (1958:282) has recently orphaned the Australian and New Guinean *C. gracilipes* Miers, 1879 and the Indian *C. andamanica* Alcock, 1895 by the transference, to the mithracine *Stenocionops* Desmarest, 1823, of *Chorilibinia angusta* Lockington, 1877, type species (by monotypy) of *Chorilibinia* Lockington, 1877. The Indian and Australian species are completely different from *C. angusta* and resemble species of *Libinia* Leach and *Libidoclea* H. Milne Edwards & Lucas among the American Pisinae. However, examination of *C. gracilipes* (numerous specimens including relatively large males and females from the Australian Museum's collections; reg. no. P. 14931, Albany Passage, N. Queensland, Melbourne Ward, 19 August 1928) shows that it differs from such American species in two important characters. First, the female abdomen comprises only five free segments (fourth to sixth

inclusive fused) in contrast to the seven of *Libinia* and *Libidoclea*. Secondly, the male first pleopod is of the pisoidiform type with a tapered, acute apex and subterminal aperture in contrast to the scyriform type possessed by the American species. *C. andamanica* and *C. gracilipes* resemble each other in structure of the orbit, form of the rostrum, shape of the carapace and comparative length of the ambulatories; *C. andamanica* also has a five-segmented abdomen in the female (Alcock 1895). The form of the male first pleopod is unfortunately unknown for the Indian species. A new genus thus seems to be required for these two Indo-West-Pacific species. The name *Chlorolibinia* published by Haswell (1882:17) is surely a mistake for Lockington's genus as the latter's name follows the name of the genus. Being an incorrect subsequent spelling, *Chlorolibinia* is unavailable for use under article 33(b) of the International Code of Zoological Nomenclature. The name *Aust.olibinia* is therefore proposed and the genus is diagnosed below.

Austrolibinia n. gen.

Chorilibinia Lockington; Miers 1879b: 7; (part: *C. gracilipes* Miers, 1879). Alcock 1895: 221 (part: *C. andamanica* Alcock, 1895)

Chlorolibinia Haswell, 1882c: 17; incorrect subsequent spelling of *Chorilibinia* Lockington, 1877.

Carapace pyriform, armed with a few slender spines and bearing posteriorly a broad, medially acute lobe. Rostrum united in basal half, consisting distally of two acute, divergent spines. Supraorbital eave well expanded, anterolaterally and posterolaterally acute, separated from the large, cupped postorbital lobe by a very narrow fissure; intercalated spine absent. Basal antennal article of moderate width, provided with a prominent lobe laterally at its base. Ambulatory legs long and slender, the first about twice carapace length. Chelipeds shorter than the first ambulatory leg in both sexes, chelae moderately inflated in male. Abdomen of seven segments in the male, of five in the female, fourth to sixth fused. First pleopod of male slender, tapering, apically acute, aperture subterminal (based on C. gracilipes only).

Type species: Chorilibinia gracilipes Miers, 1879.

V. THE SPECIES

The characters which are of value at the specific level are for the most part different in each genus. For instance, in the genus Notomithrax, the form of the crests on the carpus of the cheliped is of importance; in nearly all majines the number and arrangement of the spines on the carapace are a reliable guide but appear to be of little use in many pisines. Several characters which are widely used at the specific level unfortunately differ with age and/or sex. These include the shape of the chela and abdomen which change with growth, often in a single moult, and also differ according to sex; relative proportions of the carapace and length of the spines which change with growth, the carapace becoming wider (particularly in pisines and majines) and the spines shorter and blunter; and the number of free segments in the abdomen which is often different in males and females of the one species. In Huenia species the shape of the carapace is strikingly different in males and females. Cases in which sexual

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dimorphism has resulted in the original description of two species, one based on the male and one on the female, are, as in other groups of animals, not infrequent. The shape of the merus of the third maxilliped and of the basal antennal article are often used diagnostically but in some species the degree of spinulation or tuberculation of these two structures may change during growth.

Among the 45 species listed by Haswell (1882c), 16 have since suffered specific name changes. Some of these have been mentioned in the preceding section. Some species, particularly among the Acanthonychinae, are now recognized as highly polymorphic so that numerous names are reduced to a single valid one. This is true, for example, in the genera Oncinopus de Haan, Menaethius Latreille and Huenia de Haan although the number of Australian species currently recognized is the same as that listed by Haswell. Specific name changes have taken place, since Haswell's time, particularly in the genera Naxia Latreille, Chlorinoides Haswell, Micippa Leach and Tiarinia Dana (see references in key). Special mention should be made of the relatively recent recognition that Platymaia wyvillethomsoni Miers is a western Pacific species distinct from the Indian Ocean P. alcocki Rathbun (P. wyvillethomsoni) of Alcock and later authors) (Rathbun 1918); Calman's (1900) Torres Strait material of Xenocarcinus tuberculatus is correctly referable to X. depressus Miers (Gordon 1934, Sakai 1965) whilst Xenocarcinus tuberculatus is a western Pacific species distinct from the Indian Ocean X. alcocki Laurie (Sakai 1965);

Paramicippa hispida Baker (*Eruma hispida* of McCulloch) is synonymous with *Anacinetops stimpsoni* Miers (Balss 1935); *Schizophrys dama* (Herbst) is a western species in Australia distinct from the widespread *S. aspera* (H. Milne Edwards) (Balss 1935, Yaldwyn 1964); *Cyclax spinicinctus* Heller (?= *C. perryi* Dana) is distinct from *C. suborbicularis* (Stimpson) (Forest & Guinot 1961); *Micippa platipes* Ruppell and *M. philyra* (Herbst), often considered synonymous, are in fact distinct (Buitendijk 1939); *Notomithrax ursus* (Herbst) includes *Paramithrax latreillei* Miers (Bennett 1964, Griffin 1963a) and definitely occurs in Australia (McNeill 1953); the Australian material of *Paramithrax peronii* mentioned by Haswell (1882c) is correctly referable to *Notomithrax minor* (Filhol) (Bennett 1964); *Leptomithrax australiensis* Miers and *L. spinulosus* Haswell are both synonyms of *L. gaimardii* (H. Milne Edwards) (Griffin 1963b); *Achaeus fissifrons* (Haswell) includes *A. tenuicollis* Miers (Griffin and Yaldwyn 1965); and that *Sargassocarcinus foliatus* Ward also occurs in Japan where it has been known under the older but generically inaccurate name of *Mimulus cristatus* Balss (Sakai 1965). In this paper advantage is taken of the remarks of previous carcinologists to consider *Cancer aragnoides* Rumphius (specific name misspelt *arachnoides* by later workers), *Cancer longipes* Linnaeus, *Egeria indica* Leach and *E. herbstii* H. Milne Edwards a single species, *Phalangipus longipes* (Miers 1884: 182, Alcock 1895: 224 and Grant & McCulloch 1906:27). Similarly, *Naxia cerastes* Ortmann is considered synonymous with *Naxia taurus* Pocock and included as *Naxioides taurus* (Alcock 1895: 220, Calman 1900: 37). Both these species need investigation.

The published papers forming appendix II and supporting papers 1 - 3 are located together at the end of this thesis.

Supporting paper number 4

"A Review of the Australian Majid Spider Crabs (Crustacea, Brachyura)."

The manuscript which follows was submitted for publication in the Australian Zoologist in September, 1965.

A REVIEW OF THE AUSTRALIAN MAJID SPIDER CRABS (CRUSTACEA, BRACHYURA)

SUMMARY

An historical account is given of taxonomic studies of spider or masking crabs in Australia and overseas. The basis of the review is a key to all but two of the species known to occur in Australia. The key includes information on synonymies, geographic and bathymetric distribution and references to descriptions and illustrations of the species. Characters which are important in the classification are briefly reviewed. Zoogeographical relationships of the fauna are discussed.

The family Majidae is currently divided into seven subfamilies mainly on the basis of orbital configuration, form of the rostrum, abdomen and first pleopod of the male. All but one of the subfamilies are represented in the Australian fauna which is considered to comprise 95 species in 45 genera. This is about twice the number of species and genera listed by Haswell (1882c) in his "Catalogue". About one-third of the species have been recorded from Australia on only a single occasion. Numerous genera and species are in need of detailed reinvestigation.

The fauna is rather clearly partitioned into a tropical group with widespread Indo-West-Pacific relationships and a temperate group related to tropical Australia and/or the Indo-West-Pacific rather than to temperate regions outside Australia. There are no clear boundaries between these two faunas but rather quite broad transition areas. Thirty-seven species and five genera, most of which are temperate, are restricted to Australia.

1. INTRODUCTION

One of the most characteristic features of spider crabs of the family Majidae is the presence on the carapace and legs of special curled or 'hooked' hairs which aid in the attachment of various kinds of epifauna and flora, especially seaweeds (for example see McNeill 1923). These organisms are placed in position by the crab with the aid of the chelipeds which are able to reach up on to the dorsal surface of the carapace. For this reason majid crabs are sometimes called "masking crabs" or "seaweed crabs". Of special interest in these crabs are the orbits which may be expanded in various ways and surrounded by a seemingly complex array of spines. The legs are often long and slender and the carapace usually triangular or pyriform. Spider crabs range in size from a few millimetres to more than a metre in carapace length and are found in almost all seas and oceans. They form a relatively important part of the benthos and may be locally very abundant on the shelf although some species extend considerable distances down the continental slope to depths as great as 1000 fathoms.

Substantial revisions of the family Majidae have been undertaken on a world-wide scale by Dana (1851), Miers (1879c), Alcock (1895) and Balss (1929). Sakai (1938), Stephensen (1945) and Garth (1958) have adapted Balss's scheme to the faunas of Japan, the Iranian Gulf and America respectively. In the course of these revisions the Majidae have been arranged in several very different fashions (see historical reviews by Miers (1879c) and Garth (1958)). Early workers such as Dana and Miers grouped the species in several families and a large number of subfamilies - Dana's arrangement comprised five families and no less than 27 subfamilies. Alcock's was the first of these major revisions to contain the species in a single family. This was divided into four subfamilies and seven "alliances". Whereas revisors before Balss had proceeded by rearrangement of previous schemes, Alcock's groups of genera were left almost untouched by Balss, his alliances in some cases being elevated to subfamilial rank as much as they were conceived. The number of subfamilies currently recognised stands at seven following the work of Garth.

Many morphological characters have been used in these different classifications and some have been shown to be unreliable guides to phylogenetic relationships (see Section III). Characters concerned with the form of the orbit still dominate the classification but Garth has found, in the Pacific American fauna, groups of genera showing vast agreements in the form of the male first pleopod. This appendage is now realized to be of great value in the taxonomy of nearly all families of crabs.

The first Australian spider crabs to be described were made known by the European naturalists Herbst, Latreille and H. Milne Edwards in the early nineteenth century. In the second half of that century the work of Dana, Stimpson, Miers and Haswell resulted in substantial additions to knowledge of the Australian spider crab fauna. Dana in 1852 dealt with the Crustacea of the U.S. Exploring Expedition of 1838 – 42, Stimpson with the Crustacea of the North Pacific Exploring Expedition led by Ringgold and Rodgers (Stimpson (1857) - full report not published until 1907). Haswell published six papers between 1879 and 1882 and in 1882 (Haswell 1882c) provided the first list of all species known from Australia. But Miers's important reports on the material collected by the "Alert" in 1881-2 (Miers 1884) and by the "Challenger" in 1873-76 (Miers 1886) outdated Haswell's list to some extent. So too did the reports of W.T. Calman (1900) and A. Ortmann (1894) on collections of Brachyura from Torres Strait.

Haswell's work at the Australian Museum was followed by that of Thomas Whitelegge whose report on the Crustacea collected off eastern Australia by the "Thetis" (Whitelegge 1900) may be particularly mentioned. W.H. Baker (1905, 1906) dealt with South Australian Brachyura and S.W. Fulton, F.E. Grant and Alan R. McCulloch all paid some attention to south-eastern Australian species in the first and second decades of the present century. In the 1920's Herbert M. Hale (1924, 1927, 1929) reported on southern and western species. The numerous reports, from the 1890's to the 1920's, by Mary J. Rathbun of the Smithsonian Institution at the same time added several species to the Australian lists and extended the known ranges of many others; two reports (Rathbun 1914;1924) dealt with collections from western Australia. S.K. Montgomery's report on the Brachyura of the Percy Sladden Trust Expedition to the Abrolhos (Montgomery 1931) and Dr. Heinrich Balss's paper (1935) on the material collected by the Hamburg Museum's Expedition to south-western Australia in 1905 are the latest sources of information on western spider crabs. The contemporary and later work of Frank A. McNeill and Melbourne Ward, both at the Australian Museum, dealt mainly with north-eastern species.

The present situation with regard to the Australian majid spider crab fauna is thus as follows. No revisionary treatment has ever been attempted and no comprehensive guide has appeared since the time of

Haswell. Until recently only McCulloch (1908, 1913) had completed revisions at the generic level. Nearly all reports dealing with majids have merely added species or extended known geographic ranges. The most important recent references to Australian species are those primarily treating overseas faunas (e.g. Sakai 1938, 1965; Buitendijk 1939; Barnard 1950; and Forest & Guinot 1961). The number of known valid genera and species has doubled since the time of Haswell and collections have continued to accumulate at various museums, particularly the Australian Museum, Sydney and the Western Australian Museum, Perth. Several areas of the Australian coastline remain uninvestigated, particularly that west of Torres Strait south to Broome and most of the Great Australian Bight. The Australian Museum possesses a fine catalogue of all described genera and species. Not the least important of the many problems which therefore remain unanswered is the question of whether the Australian genera can be grouped, on the basis of the male first pleopods (unknown in the vast majority of local species), in an arrangement which parallels that found by Garth.

The present paper attempts to bring together available information on the Australian Brachyura of the family Majidae. This information is presented in the form of a key to genera and species with distributional and other information included. The following discussions centre around this key. Current problems are pointed out but there is no intention here of giving a general revision. Adequate treatments of the morphology of members of this family are given by Rathbun (1925), Garth (1958) and Griffin (in press,b). Terminology, unless otherwise indicated, follows that used by Rathbun and Garth and by Griffin in previous papers. Although most information used in the key is taken from the literature, a considerable amount of material comprising most of the species represented in Australia, has been examined at the Australian Museum over the past three years.

II. THE FAMILY

The Majidae belong, with the Hymenosomidae (flat-back crabs) and the Parthenopidae (calthrop crabs), to the superfamily Oxyrhyncha. All three families possess an anteriorly narrowed and produced carapace with prominently expanded branchial regions, large epistome, quadrate buccal cavity and longitudinally folded antennules. The characters which chiefly distinguish majid crabs from other families of the Brachyura are 1) the possession of specially mobile chelipeds; 2) fusion of the well-developed second article of the antenna (usually called the basal antennal article) to the epistome and often also to the front; 3) the comparatively incomplete orbits; 4) articulation of the palp of the external maxillipeds at the anteromedial angle of the merus; and 5) the much greater length of the first pleopods of the male relative to the second pair. The family has usually been considered in the past to share with other Oxyrhyncha nine pairs of gills on each side but Hartnoll (1964) has recently shown that this number is sometimes reduced in the Majidae to seven or eight.

It should be mentioned that the term Maioidea used by Dana and Miers is partially synonymous with Oxyrhyncha (as now understood) and not with the term Majidae (until recently frequently spelt Maiidae). In Dana's and Miers's time the Maioidea included only the Majidae and the Parthenopidae; de Haan's (1839) addition of the Hymenosomidae did not gain general acceptance until after Rathbun (1925).

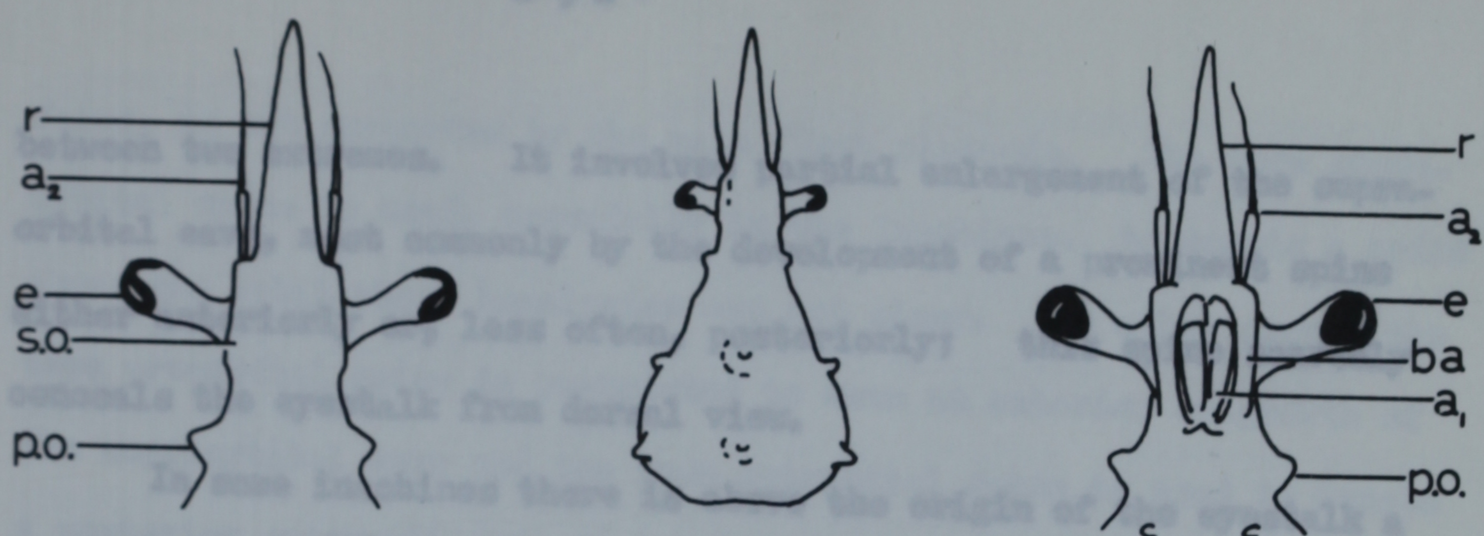
As to the evolution and relationships of the Oxyrhyncha, Glaessner (1960:46) states, "The Oxyrhyncha, or spider crabs, are ... unrepresented before the Tertiary except by unidentifiable fragments. The pointed rostrum ... and the prominent mesogastral-cardiac ridge, together with the elongate cephalothorax, place this group much closer to the Oxystomata than to the Brachyrhyncha, but it is more advanced in the organization of its mouthparts."

III. THE SUBFAMILIES

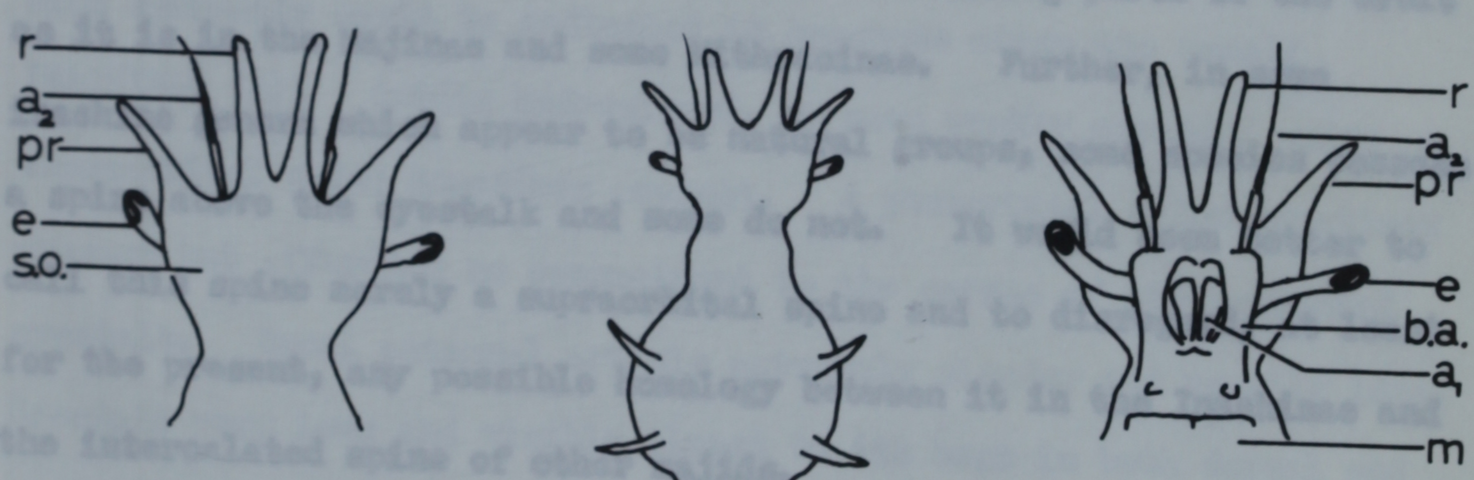
The subfamilial arrangement adopted here is that proposed by Garth (1958) which is a modification of the schemes of Alcock (1895) and Balss (1929). In the delimitation of subfamilies and in the arrangement of genera within them particular attention has been paid to the structure of the orbit, i.e., the degree of expansion of the anterolateral part of the carapace above the origin of the eyestalk (the "supraorbital eave"), the presence or absence, and form of, a spine behind the eave (the "postorbital spine") and the degree of expansion of the basal antennal article. These are characters used before Alcock by Miers (1879c) and to some extent by Dana (1851). H. Milne Edwards (1834) considered the length of the ambulatory legs to be important and the classification proposed by de Haan (1839) was based on the shape of the merus of the third maxillipeds. Use of these latter characters was criticised by Miers. In 1861 Claus proposed a classification based on the form of the basal antennal article. Use of this character was criticised by Stimpson in 1871. Balss laid particular stress on a further feature associated with the structure of the orbit: the presence or absence of a spine (the "intercalated spine") between the eave and the postorbital lobe. However, later workers on the group (Sakai 1938 and Garth 1958) have considered that Balss laid too much stress on this feature (see below). The relative size of this spine is sometimes variable with either growth or geographical locality (Garth 1958; Griffin, unpublished). Balss also introduced three other characters: the number of free segments of the abdomen(basically seven but sometimes reduced by coalescence or fusion involving segments four to six inclusive), the degree of development of the interantennular spine (the true rostrum of the zoea) and the degree of fusion of the (pseudo) rostral spines.

In the key presented here genera within each subfamily are arranged in a series which begins with forms with a double rostrum and seven free abdominal segments in both sexes and ends with those in which the rostral spines are partly or wholly fused and the number of free segments in the abdomen is reduced. In this respect the key resembles those provided by Garth (1958). Implicit in such a presentation is the concept that parallel evolution has proceeded independently within each subfamily. The genera at the beginnong of the series are considered to be primitive and those at the end advanced. This is in accordance with the ideas of Balss who considered that a well developed interantennular spine and the presence of an intercalated spine were also primitive features.

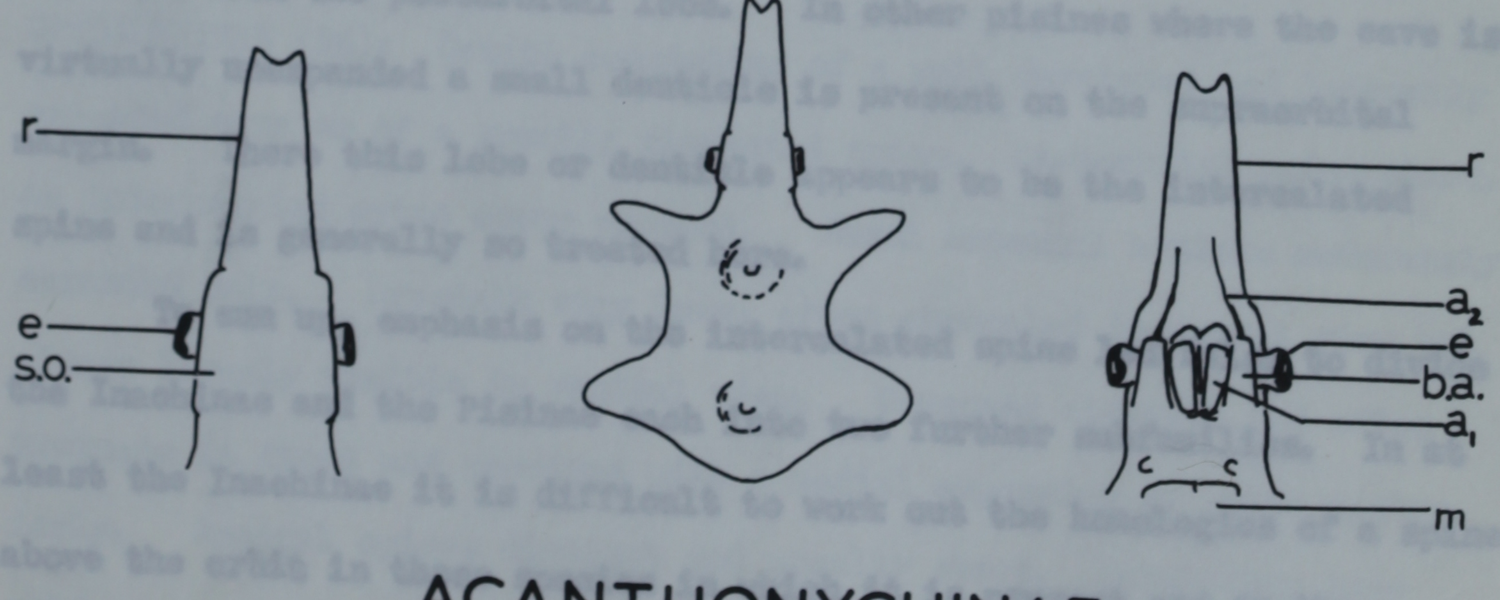
Some aspects of orbital structure require further clarification. The term "commencing orbit", used in respect of some of the Opthalmiinae, Acanthonychinae and Pisinae, is intended to contrast with the unformed orbits of the Inachinae and some members of the Acanthonychinae on the one hand and with the complete or almost complete orbits of the Majinae and Mithracinae on the other. The commencing orbit is thus intermediate



INACHINAE



OPHTHALMIINAE



ACANTHONYCHINAE

TEXT-FIG. 1 Generalized morphology of the subfamilies Inachinae, Ophthalmiinae and Acanthonychinae. Front of the carapace from above at left and from below at right; whole carapace from above in the middle. Abbreviations: a_1, antennule; a_2, antenna; a.o., antorbital spine; b.a., basal antennal article; e, eye; m, mouthfield; p.o., postorbital lobe; pr, preorbital spine; r, rostrum; s.o., supraorbital eave.

between two extremes. It involves partial enlargement of the supraorbital eave, most commonly by the development of a prominent spine either anteriorly or, less often, posteriorly; this spine scarcely conceals the eyestalk from dorsal view.

In some inachines there is above the origin of the eyestalk a variously developed spine, considered by Balss to represent the intercalated spine. However, in the Inachinae, this spine is very seldom separated by distinct fissures from the surrounding parts of the orbit as it is in the Majinae and some Mithracinae. Further, in some inachine genera which appear to be natural groups, some species possess a spine above the eyestalk and some do not. It would seem better to call this spine merely a supraorbital spine and to disregard, at least for the present, any possible homology between it in the Inachinae and the intercalated spine of other majids.

A similar difficulty exists in many of the Pisinae. In some the postorbital lobe is provided on the upper anterior edge close to the base with a prominent accessory lobe and in a few species this lobe is quite distinct from the postorbital lobe. In other pisines where the eave is virtually unexpanded a small denticle is present on the supraorbital margin. There this lobe or denticle appears to be the intercalated spine and is generally so treated here.

To sum up, emphasis on the intercalated spine led Balss to divide the Inachinae and the Pisinae each into two further subfamilies. In at least the Inachinae it is difficult to work out the homologies of a spine above the orbit in those species in which it is present and in the Pisinae Garth has found that such a division, in the Pacific American forms, is not supported by the male first pleopods. The term supraorbital spine is used, especially in the Inachinae,, to denote a spine above the orbit where homologies are not clear. In other groups the term preorbital spine is restricted to mean an anterior outgrowth of the supraorbital eave and the term antorbital spine is used to denote a posterior outgrowth (see figure in Griffin, in press, a).

The characters of the six subfamilies represented in Australia are now given (the number of the couplet in the key at which genera of each subfamily begin is indicated in brackets after the name):

INACHINAE (4): Orbits undeveloped, or eave weakly expanded only; a supraorbital spine sometimes present. A postorbital spine sometimes present but affording no concealment to the cornea of the retracted eyestalk. Basal antennal article extremely slender and usually long. Eyestalk very long and visible almost to its base in both dorsal and ventral view. Carapace subtriangular or sometimes subpyriform or occasionally circular. Rostrum sometimes of a single spine, and frequently short. Ambulatory legs frequently extremely long and slender.

OPTHALMIINAE (26): Orbits consisting of a well developed and laterally expanded eave or of a greatly elongated spine. Postorbital spine short. An intercalated spine never present. Basal antennal article moderately expanded only. Eyestalk very long, often concealed in dorsal view but always largely visible in ventral view. Carapace elongate and often truncate in front and provided with a medial expansion or spine posteriorly. Rostral spines distinct and usually short. Ambulatory legs seldom very long.

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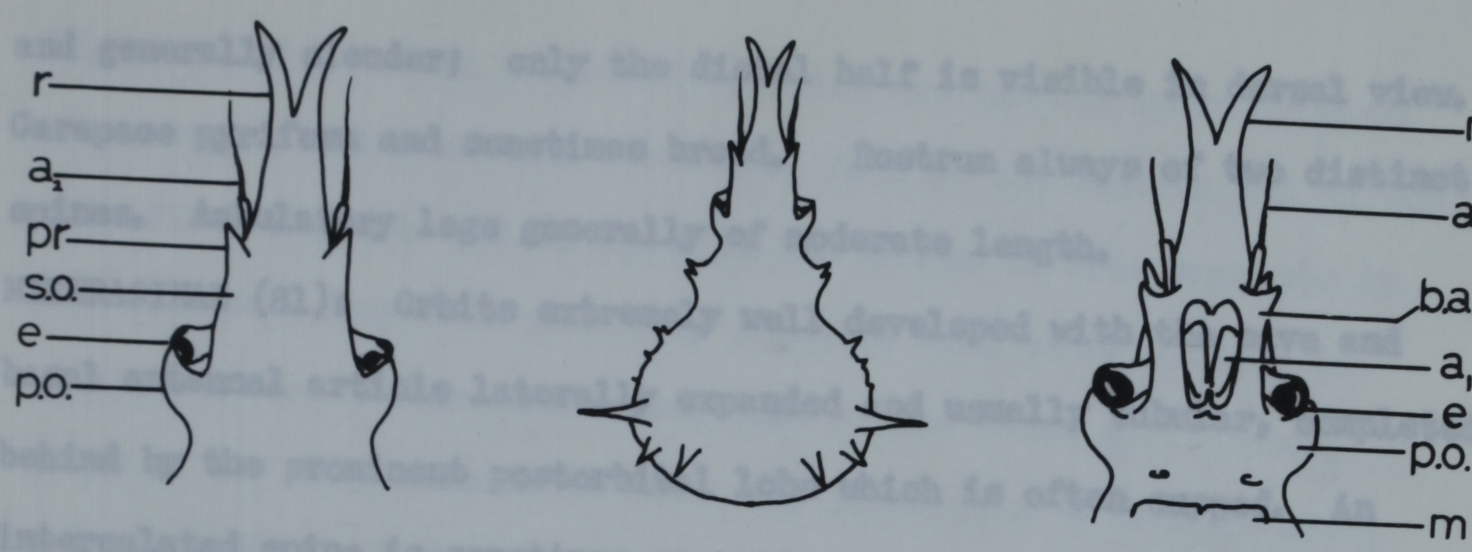
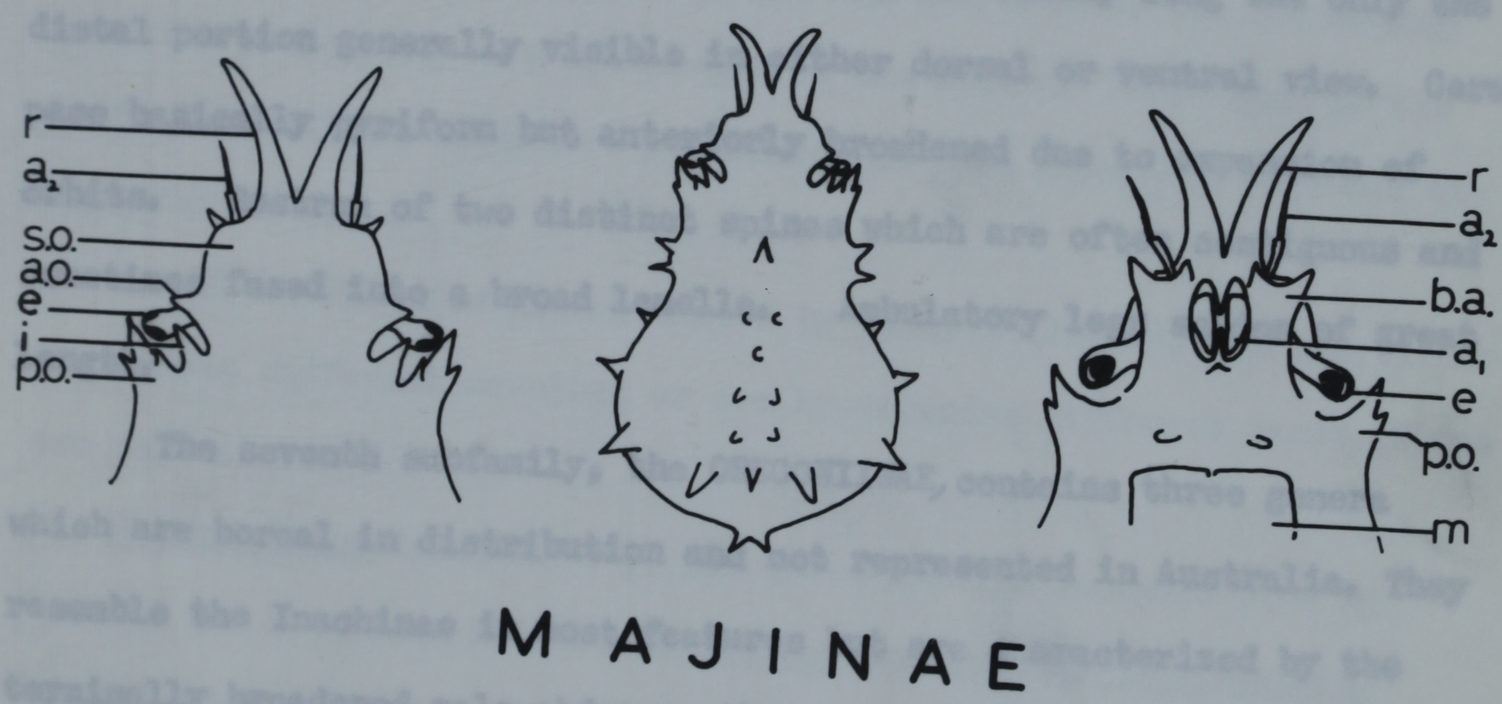
ACANTHONYCHINAE (29): Orbits undeveloped, eave rounded or forwardly produced as a preorbital spine. Postorbital spine, if present, simple and affording no concealment to eyestalk. Basal antennal article not very wide and characteristically truncate triangular. Eyestalks extremely short and often sunk in sides of rostrum. Carapace basically pyriform but characteristically twice expanded laterally at hepatic and branchial margins. Rostrum consisting either of two distinct spines or sometimes of a huge "beak". Ambulatory legs short or at most of moderate length.

PISINAE (36): Orbits with a weakly expanded eave either produced anteriorly as a preorbital spine or acute or sometimes posteriorly acute, or else weakly expanded midway along and almost confluent with the postorbital lobe. Intercalated spine present or absent, sometimes a small denticle or lobe close to the postorbital lobe. Postorbital lobe always well developed and cupped but not completely concealing the eyestalk from dorsal view. Basal antennal article slightly to broadly expanded and usually produced into a spine anterolaterally. Eyestalk typically short and bulbous with a large cornea. Carapace always pyriform although sometimes very wide. Rostrum frequently bifid for distal half only. Ambulatory legs often very long and slender.

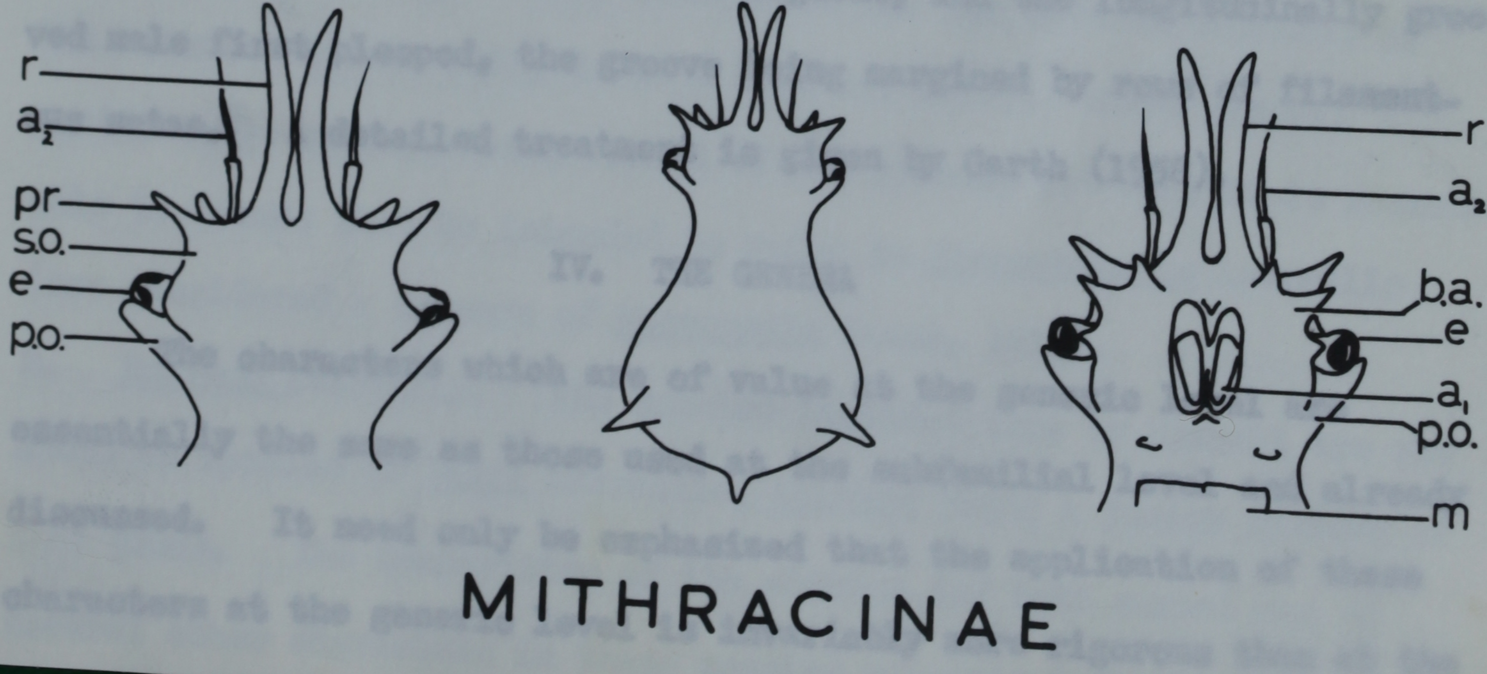
MAJINAE (62): Orbit well developed, comprising above a laterally expanded eave which is always acute posteriorly and sometimes produced into a spine, an intercalated spine and a postorbital spine which is sometimes simple and sometimes cupped and occasionally armed with an accessory spine on the upper anterior edge near the base. Basal antennal article moderately broad and rectangular and frequently armed with spines at both anteromedial and anterolateral angles. Eyestalks of moderate length



PISINAE



MAJINAE



MITHRACINAE

TEXT-FIG. 2 Generalized morphology of the subfamilies Pisinae, Majinae and Mithracinae. Arrangement and abbreviations as in text-fig. 1.

and generally slender; only the distal half is visible in dorsal view. Carapace pyriform and sometimes broad. Rostrum always of two distinct spines. Ambulatory legs generally of moderate length.

MITHRACINAE (81): Orbits extremely well developed with the eave and basal antennal article laterally expanded and usually tubular, completed behind by the prominent postorbital lobe which is often cupped. An intercalated spine is sometimes present. Eave sometimes forwardly produced into a preorbital spine or lobe, and sometimes prolonged posteriorly into an antorbital spine. Eyestalk moderately long but only the distal portion generally visible in either dorsal or ventral view. Carapace basically pyriform but anteriorly broadened due to expansion of orbits. Rostrum of two distinct spines which are often contiguous and sometimes fused into a broad lamella. Ambulatory legs seldom of great length.

The seventh subfamily, the OREGONIINAE, contains three genera which are boreal in distribution and not represented in Australia. They resemble the Inachinae in most features but are characterized by the terminally broadened male abdomen, the seventh segment being quadrate and deeply inserted into the sixth segment, and the longitudinally grooved male first pleopod, the groove being margined by rows of filamentous setae. A detailed treatment is given by Garth (1958).

IV. THE GENERA

The characters which are of value at the generic level are essentially the same as those used at the subfamilial level and already discussed. It need only be emphasized that the application of these characters at the generic level is invariably more rigorous than at the higher levels. Thus congeneric species are usually considered to share very similar orbital structure, form of the rostrum and of the male first pleopods and to agree in the number of free segments in the abdomen. They also generally resemble each other closely in carapace shape and ornamentation, form of the third maxillipeds, shape of the male abdomen (a character introduced by Shen in 1932) and often shape of the male chela but seldom in actual size and in relative length of the ambulatory legs.

The remaining part of this section and most of the succeeding one will be devoted to a discussion of the several lower taxa of the Australian Majidae which are considered to pose important problems at the present time.

Of the 24 majid genera listed by Haswell (1882c), ten now either have quite different meanings or are known under different names. These are as follows:

1. Stenorhynchus Lamarck. Of the three species included here by Haswell two have been shifted to Achaeus and one, S. curvirostris, has not been collected since its discovery (see next section). Lamarck's genus is currently recognized for two species confined to the Americas (Garth 1958, Garth & Holthuis 1963); since Haswell mentions the rostrum being formed of two spines, not one, it is reasonable to assume that he intended to refer to Stenorhynchus Latreille (now considered a synonym of Macropodia Leach, 1814).

2. Halimus Latreille. The species included here by Haswell are now known as species of Naxia Latreille, Halimus being a junior synonym of that genus. The composition of the abdomen (of both sexes) and of several other characters in these species requires investigation to

determine its relationships to the New Zealand representative of the genus (see Griffin, in press). The comparatively well developed orbits and distally expanded ambulatory propodi set this genus apart from other inachines. Haswell's subgenus *Microhalimus*, with its single species, *M. deflexifrons*, was included as a subgenus of *Naxia* by McCulloch (1908). For the sake of convenience, *Microhalimus* is here not given subgeneric status though it is true that *M. deflexifrons* appears to differ in some important features of the orbit from other species of *Naxia*, particularly in the number and arrangement of the spines above and behind the orbit. Such disagreement is especially obvious when it is compared with those species with which it agrees in the slight expansion of the ambulatory propodi.

3. *Naxia* H. Milne Edwards. Haswell listed one species under this genus, *Pisa serrulifer* Guérin. This was transferred to *Naxioides* A. Milne Edwards (of which *Naxia* Miers is a synonym) by Rathbun (1914) and later (Rathbun 1924) set apart in a genus of its own, *Paranaxia*; H. Milne Edwards's genus is a synonym of the latter.

4-6. *Gonatorhynchus* Haswell, *Paramithrax* H. Milne Edwards and *Chlorinoides* Haswell. *Gonatorhynchus* has recently (Griffin 1963b) been sunk in *Paramithrax* which has been recognised as monotypic. There appear to be some important similarities in orbital structure between *P. barbicornis* and *Anacinetops stimpsoni* although the species are at present placed in different subfamilies. The meaning attributed *Paramithrax* in Haswell's time has also been changed through the removal of several species to *Chlorinoides* (see Griffin, in press a). These latter species are the ones often placed in Acanthophrys A. Milne Edwards, a genus synonymous with Hyastenus White.

7 - 9. Egeria Latreille, Cyclomaia Stimpson and Parathoe Miers. These have been replaced respectively by Phalangipus Latreille, Cyclax H. Milne Edwards and Perinia Dana without change in meaning. In addition Eucinetops Stimpson no longer appears in the Australianlists, Anacinetops Miers having been accepted for E. stimpsoni Miers (see Balss 1935). One genus listed by Haswell among the Oxyrhyncha, the monotypic Pleurophricus A. Milne Edwards, has recently been included among the Cymopolidae (now known as the Palicidae - see Holthuis 1962: 244, 249) by Balss (1957: 1662) and is not treated here.

10. Chorilibinia Lockington. This genus was listed by Haswell under the name Chlorolibinia; it will be discussed in more detail at the end of this section.

A nomenclatural point which should be mentioned here concerns the genus Camposcia. Balss (1957: 1620) lists this as Camposcia Desmarest, 1823. Yaldwyn (pers. comm.) has kindly informed me that Desmarest's reference (Dict. Sci. nat. 28: 259,262) is to an MS name of Leach, Camposia. Other authors before Latreille (1829) (in Cuvier's Reg. Anim. IV.(2):60) also used this spelling. However, it appears that Latreille who used the name Camposcia, was the first to include a species in the genus. Camposia of Desmarest and others would, therefore, appear to be a 'nomen nudem'. The species included in Camposcia Latreille, 1829 was C. retuia which was listed without comment by H. Milne Edwards (1834:283) as Camposcia retusa Latreille, 1829. All subsequent workers used these spellings which are therefore followed here.

Among other genera which need re-examination in regard to their distinctness and relationships are Xenocarcinus, Zewa, Phalangipus, Doclea, Antilibinia, Hyastenus and Micippa.

1. Xenocarcinus White. Sakai (1938:324) has placed this genus in the subfamily currently known as the Mithracinae because he considers that at least two of the Japanese species show traces of an intercalated spine. Although this structure is unknown in the Acanthonychinae, Xenocarcinus is here placed in that subfamily because of its numerous resemblances to other acanthonychinines.

2. Zewa McCulloch. This genus was introduced in 1913 for a (new) species from north-eastern Australia. At the same time the earlier described Pseudomicippe varians Miers was included because, as McCulloch noted, previous workers had expressed some doubts about the wisdom of considering this latter species to be congeneric with P. tenuipes A. Milne Edwards. McCulloch considered the presence of a large lobe above the orbit and of a spine on the posterior border of the carapace important characters in this genus. Balss (1957), however, lists Zewa as a synonym of Pseudomicippe Heller. Although comparisons of descriptions and figures of the three species (see Buitendijk 1939: 255, pl. VIII figs. 3 & 4; and Sankarankutty 1962: 160, figs. 17-23 for P. tenuipes) certainly inclines me towards Balss's view, I retain McCulloch's genus pending a fuller investigation of the Australian species.

3. Phalangipus Latreille and Doclea Leach. These two genera are among those pisines in which positive identification of an intercalated spine is difficult. In both genera the eave is poorly expanded and separated by a more or less wide hiatus from the postorbital lobe.

Phalangipus is usually regarded as possessing an intercalated spine and *Doclea* to be lacking it. Thus *P. australiensis*, which possesses a small denticle in the hiatus, is widely separated in the key from *D. profunda*, in which there is no denticle. But among species of *Doclea*, the South African *D. muricata* (Herbst) (see Barnard 1950: 49, fig. 11a) does possess such a denticle just forward of the postorbital lobe. Some rearrangement of species may be necessary. Rather striking differences in carapace shape exist between the species of *Doclea* (see Sakai 1938: pl. XXXVII) just as in *Naxioides*.

4. *Antilibinia* Macleay. Three species are at present included in this genus, one each from South Africa, the Philippines and Australia. The last two were both described by Rathbun from a few specimens and have not been since discussed on the basis of additional material. Barnard (1950:37) doubted that the Australian *A. lappacea* belongs in the same genus as the South African *A. smithii* because of differences in carapace shape and length of the rostrum; he also considered that the latter species might well be shifted to the American *Taliepus* A. Milne Edwards, again because of similarities in carapace shape. Indeed both *Antilibinia* and *Taliepus* have in the past been considered subgenera of *Epialtus* H. Milne Edwards (see Garth 1958:207). A new genus may be required for the Australian and Philippine species.

5. *Hyastenus* White. As the basis for Balss's (1929) Hyasteniinae, this extremely large genus (Balss in 1935 listed 38 species) is usually considered to be characterised especially by an absence of an intercalated spine from the orbit and by the distinctness of all seven abdominal segments. However, Laurie (1906) has noted that in his *H. irami* there

is a distinct lobe between the eave and postorbital lobe. H. convexus Miers also appears to possess such a structure and many species of Hyastenus have on the upper anterior edge of the postorbital lobe a well developed accessory lobe. Sakai (1938:280) has pointed out that the abdomen of the female of H. diacanthus (de Haan) consists of only five segments. Such features are usually considered sufficient to warrant generic separation.

6. Micippa Leach and Paramicippa H. Milne Edwards. When Paramicippa was first set up in 1834, two species, Micippa platipes Ruppell and P. tuberculosa Milne Edwards were included. The first was designated type species of Paramicippa by Miers (1879c: 662) and a definition of that genus given at the same time. The second species was alone included in Paramicippa in Miers's later revision of the two genera (Miers 1885). Such a procedure was quite invalid. Since M. platipes is now generally accepted as belonging to Micippa (Sakai 1938, Buitendijk 1939), Paramicippa should fall to that genus. If a separate genus is to be established for P. tuberculosa because of the pronounced bifid nature of its rostrum or its comparatively long eyestalks or for any other reason, a new name must be used. The situation awaits further investigation and P. tuberculosa is here included amongst species of Micippa.

Finally, among the genera introduced to the Australian lists in this paper, two require further mention; in one way they may be regarded as merely replacing names already in use.

1. Scyramathia A. Milne Edwards. In 1918 Rathbun placed Hyastenus fultoni Grant, 1905 in this genus which has recently been recognised as

a synonym of Rochinia A. Milne Edwards (Garth 1958:282). Examination of material of Grant's species (11 specimens including relatively large males and females from the Australian Museum's collections: reg. no. P.4515, 20 miles east of Babel I., Tasmania, 65-70 fms., "Endeavour" Expedition) reveals the male first pleopod as being of the "pisoidiform" type (Garth 1958:249; see also his pl. Q) with a truncate but poorly expanded apex and similar to that of Rochinia occidentalis (Faxon) (see Garth 1958: pl. Q fig. 7). H. fultoni also resembles this species in shape and type of ornamentation of the carapace, relative length of the rostrum, form of the orbit and in several other features (see Rathbun 1925: pls. 228, 229 fig. 5). It seems to fit very satisfactorily into Rochinia which genus is now added to the Australian fauna. In the Indo-West-Pacific, species of Rochinia are known also from Japan, India and South Africa.

2. Chorilibinia Lockington. Garth (1958:282) has recently orphaned the Australian and New Guinean C. gracilipes Miers, 1879 and the Indian C. andamanica Alcock, 1895 by the transference, to the mithracine Stenocionops Desmarest, 1823, of Chorilibinia angusta Lockington, 1877, type species (by monotypy) of Chorilibinia Lockington, 1877. The Indian and Australian species are completely different from C. angusta and resemble species of Libinia Leach and Libidoclea H. Milne Edwards & Lucas among the American Pisinae. However, examination of C. gracilipes (numerous specimens including relatively large males and females from the Australian Museum's collections; reg. no. P. 14931, Albany Passage, N. Queensland, Melbourne Ward, 19 August 1928) shows that it differs from such American species in two important characters. First, the female abdomen comprises only five free segments (fourth to sixth

inclusive fused) in contrast to the seven of Libinia and Libidoclea. Secondly, the male first pleopod is of the pisoidiform type with a tapered, acute apex and subterminal aperture in contrast to the scyriform type possessed by the American species. C. andamanica and C. gracilipes resemble each other in structure of the orbit, form of the rostrum, shape of the carapace and comparative length of the ambulatories; C. andamanica also has a five-segmented abdomen in the female (Alcock 1895). The form of the male first pleopod is unfortunately unknown for the Indian species. A new genus thus seems to be required for these two Indo-West-Pacific species. The name Chlorolibinia published by Haswell (1882:17) is surely a mistake for Lockington's genus as the latter's name follows the name of the genus. Being an incorrect subsequent spelling, Chlorolibinia is unavailable for use under article 33(b) of the International Code of Zoological Nomenclature. The name Austrolibinia is therefore proposed and the genus is diagnosed below.

Austrolibinia n. gen.

Chorilibinia Lockington; Miers 1879b: 7; (part: C. gracilipes Miers, 1879). Alcock 1895: 221 (part: C. andamanica Alcock, 1895)

Chlorolibinia Haswell, 1882c: 17; incorrect subsequent spelling of Chorilibinia Lockington, 1877.

Carapace pyriform, armed with a few slender spines and bearing posteriorly a broad, medially acute lobe. Rostrum united in basal half, consisting distally of two acute, divergent spines. Supraorbital eave well expanded, anterolaterally and posterolaterally acute, separated from the large, cupped postorbital lobe by a very narrow fissure; intercalated spine absent. Basal antennal article of moderate width, provided with a prominent lobe laterally at its base. Ambulatory legs long and slender, the first about twice carapace length. Chelipeds shorter than the first ambulatory leg in both sexes, chelae moderately inflated in male. Abdomen of seven segments in the male, of five in the female, fourth to sixth fused. First pleopod of male slender, tapering, apically acute, aperture subterminal (based on _C. gracilipes_ only).

Type species: _Chorilibinia gracilipes_ Miers, 1879.

V. THE SPECIES

The characters which are of value at the specific level are for the most part different in each genus. For instance, in the genus _Notomithrax_, the form of the crests on the carpus of the cheliped is of importance; in nearly all majines the number and arrangement of the spines on the carapace are a reliable guide but appear to be of little use in many pisines. Several characters which are widely used at the specific level unfortunately differ with age and/or sex. These include the shape of the chela and abdomen which change with growth, often in a single moult, and also differ according to sex; relative proportions of the carapace and length of the spines which change with growth, the carapace becoming wider (particularly in pisines and majines) and the spines shorter and blunter; and the number of free segments in the abdomen which is often different in males and females of the one species. In _Huenia_ species the shape of the carapace is strikingly different in males and females. Cases in which sexual dimorphism has resulted in the original description of two species, one based on the male and one on the female, are, as in other groups of animals, not infrequent. The shape of the merus of the third maxilliped and of the basal antennal article are often used diagnostically but in some species the degree of spinulation or tuberculation of these two structures may change during growth.

Among the 45 species listed by Haswell (1882c), 16 have since suffered specific name changes. Some of these have been mentioned in the preceding section. Some species, particularly among the Acanthonychinae, are now recognized as highly polymorphic so that numerous names are reduced to a single valid one. This is true, for example, in the genera Oncinopus de Haan, Menaethius Latreille and Huenia de Haan although the number of Australian species currently recognized is the same as that listed by Haswell. Specific name changes have taken place, since Haswell's time, particularly in the genera Naxia Latreille, Chlorinoides Haswell, Micippa Leach and Tiarinia Dana (see references in key). Special mention should be made of the relatively recent recognition that Platymaia wyvillethomsoni Miers is a western Pacific species distinct from the Indian Ocean P. alcocki Rathbun (P. wyvillethomsoni) of Alcock and later authors) (Rathbun 1918); Calman's (1900) Torres Strait material of Xenocarcinus tuberculatus is correctly referable to X. depressus Miers (Gordon 1934, Sakai 1965) whilst Xenocarcinus tuberculatus is a western Pacific species distinct from the Indian Ocean X. alcocki Laurie (Sakai 1965);

Paramicippa hispida Baker (Eruma hispida of McCulloch) is synonymous with Anacinetops stimpsoni Miers (Balss 1935); Schizophrys dama (Herbst) is a western species in Australia distinct from the widespread S. aspera (H. Milne Edwards) (Balss 1935, Yaldwyn 1964); Cyclax spinicinctus Heller (?= C. perryi Dana) is distinct from C. suborbicularis (Stimpson) (Forest & Guinot 1961); Micippa platipes Ruppell and M. philyra (Herbst), often considered synonymous, are in fact distinct (Buitendijk 1939); Notomithrax ursus (Herbst) includes Paramithrax latreillei Miers (Bennett 1964, Griffin 1963a) and definitely occurs in Australia (McNeill 1953); the Australian material of Paramithrax peronii mentioned by Haswell (1882c) is correctly referable to Notomithrax minor (Filhol) (Bennett 1964); Leptomithrax australiensis Miers and L. spinulosus Haswell are both synonyms of L. gaimardii (H. Milne Edwards) (Griffin 1963b); Achaeus fissifrons (Haswell) includes A. tenuicollis Miers (Griffin and Yaldwyn 1965); and that Sargassocarcinus foliatus Ward also occurs in Japan where it has been known under the older but generically inaccurate name of Mimulus cristatus Balss (Sakai 1965). In this paper advantage is taken of the remarks of previous carcinologists to consider Cancer aragnoides Rumphius (specific name misspelt arachnoides by later workers), Cancer longipes Linnaeus, Egeria indica Leach and E. herbstii H. Milne Edwards a single species, Phalangipus longipes (Miers 1884: 182, Alcock 1895: 224 and Grant & McCulloch 1906:27). Similarly, Naxia cerastes Ortmann is considered synonymous with Naxia taurus Pocock and included as Naxioides taurus (Alcock 1895: 220, Calman 1900: 37). Both these species need investigation.

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It is brought out later in this paper that a large number of species considered to be restricted to Australia have been recorded only once from little material. Nothing is to be gained by listing these - material of all is to be eagerly sought. Only two are mentioned here as they are not included in the key.

1. Stenorhynchus curvirostris A.Milne Edwards, 1873. This was recorded from Bass Strait and the original description was repeated by Haswell (1882c: 2). I am unable to confidently place it in a genus but it should key out somewhere near Achaeus or Achaeopsis; Miers (1886: 6,18) tentatively placed it in Achaeopsis. As already indicated (see preceding section) it may belong in Macropodia which so far is unknown from Australia.

2. Inachus australis Gray, 1831. This was not listed by Haswell. Gray's description was very short and I am unable to comment on the relationship of the species; Gray mentions that it is "somewhat allied" to Inachus arabicus Rüppell (a synonym of Menaethius monoceros Latreille whilst Miers (1886:19) considered that it might belong in Chlorinoides.

Special difficulties in satisfactorily delineating species appear to have been concentrated in a few genera, most of which still await study. Three require mention here:

1. Hyastenus. Many species appear to show rather wide geographic or age variation in ornamentation of the carapace and relative length of the rostral spines. Yet both these characters were heavily relied upon by Alcock (1895) whose arrangement is largely followed here because it is these features which have most often been mentioned in descriptions in the literature. Buitendijk (1939) has illustrated the male first pleopods of several Australian species.

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2. Micippa. Species of this genus also appear to show the kind of wide variation exhibited in Hyastenus. Characters such as the presence of knobs on the spines should be used with caution, as in Chlorinoides.

3. Tiarinia. Species of this genus are in at least as much confusion as those of any other. Only T. angusta, which stands out because of its spinulous rostrum, is easily recognised. The status of all other species is in doubt although descriptions and illustrations provided by Sakai (1938, 1965) and by Buitendijk (1939) are of assistance. The main requirement is definition of the species on the basis of the male first pleopod (as in many other species groups), followed by an analysis of the tuberculation and spinulation of the dorsal surface and margins of the carapace and their changes during growth. Measurements given by Buitendijk of three dimensions of the carapace in T. cornigera (Latreille) and T. gracilis Dana (of which the Australian and western Pacific T. depressa Stimpson may be a synonym) reveal no relative growth differences.

Only four other species need be mentioned.

1. Entomonyx spinosus Miers. This quite widespread Indo-West-Pacific species, of which Macrocoeloma nummifer Alcock is a synonym, has been recorded only once from Australia (as Acanthophrys spinosus by Balss 1929). Entomonyx is resurrected as a monotypic genus to accommodate it (Griffin, in press, a).

2. Criocarcinus superciliosus (Herbst). This widespread Indo-West-Pacific ophthalmine is included in the key on the basis of material from the Great Barrier Reef identified by F.A. McNeill (in prep.).

3. *Achaeus* sp. A single specimen in the Australian Museum's collections appears to constitute an unnamed species of *Achaeus*. Additional characters of this species have been given elsewhere (Griffin & Yaldwyn 1965).

4. *Chlorinoides goldsboroughi* Rathbun. This species, previously known only from Hawaii, is included in the key on the basis of two specimens in the Australian Museum's collections taken off New South Wales. Additional characters for separating this species from the closely related Japanese *C. brevispinosa* Yokoya have recently been given by Sakai (1965:83).

VI. THE KEY

The following key to genera and species includes all species recorded in the literature from Australian localities, with the exception of *Stenorhynchus curvirostris* and *Inachus australis* (see above).

Apart from the characters given for each taxon, the following information is also presented. In the case of genera, the name is followed by the world geographic range; references to important accounts of the genus as a whole, or merely of non-Australian species; and the approximate number of known valid species. In the case of species the name is followed by specific synonyms (as recorded in the Australian literature); size; distribution within Australia; distribution outside Australia; bathymetric range (for details of last four see below); further distinguishing characters or other information which may be of assistance in more positively identifying the species; and finally (in brackets), one or two references to descriptions and illustrations of the species.* Where a genus is monotypic

(Note: Six species are figured in this paper - pls. 1-3 - and an appropriate reference to these is included in the key. In the case of four species, *viz.*, *Huenia bifurcata*, *Hyastenus auctus*, *Hyastenus sebae* and *Tiarinia elegans*, these are the first illustrations provided; that of *Paranaxia serpulifera* is the first illustration of an adult.)

or represented in Australia by only a single species, the above information follows on immediately from the remarks concerning the genus.

Size: Relative size (total carapace length including rostrum) is indicated as follows: very small: less than 10 mm, small: 10-20 mm, medium: 20-40 mm, large: 40-80 mm, very large: more than 80 mm.

Australian distribution: The Australian coastline is divided into six regions for the purpose of this review: SE (south east): Tasmania, Victoria and New South Wales, or, more correctly, Kangaroo Island to Brisbane; NE (north east): remaining part of the eastern seaboard; N (north): Torres Strait; NW (north west): remaining portion of northern coastline to Shark Bay; SW (south west): west coast from Shark Bay and along south coast to Eucla; and S (south): rest of the Great Australian Bight to Spencer's Gulf. The divisions south and north are used here to emphasize the fact that some species are recorded from South Australia but not Victoria, or from Torres Strait but not the adjacent Barrier Reef or Gulf of Carpentaria; they are thus convenient divisions only and may have no real zoogeographic basis (see Section VII). It should be noted that this review treats only species recorded from the Australian mainland, Tasmania, the inshore islands off the western and eastern coastlines, New Guinea and Lord Howe Island.

Overseas Distribution: The grouping and designation of overseas localities in the main follows Ekman (1953). Thus the tropical to warm temperate area of the Indian and western Pacific Oceans are considered to comprise the following faunal subregions (outside Australia): Indian Ocean; Indo-Malaya (including the Philippines); tropical and subtropical Japan (designated simply as Japan); central Pacific (excluding Hawaii); and Hawaii. Taxa, the distribution of which

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extends through the Indian Ocean and Japan and any other subregions are designated in the key as Indo-West-Pacific.

Bathymetric distribution: The depth at which species occur is divided into five categories: littoral: intertidal; sublittoral: down to 10 fms; shallow offshore: 10-50 fms; lower shelf: 50-100 fms; and slope: over 100 fms. In the case of species which extend down the slope, the deepest recorded occurrence is given.

Finally, an attempt has been made in the key, at least at the generic level and above, to use as far as possible characters which are considered important from the phylogenetic point of view; in most cases ready separation is achieved. The key is set out with contrasting couplets adjacent so as to permit easier comparison of the divisions.

KEY TO SUBFAMILIES OF MAJID BRACHYURA AND AUSTRALIAN GENERA AND SPECIES

1 Eyes either without orbits, or with incomplete or commencing orbits. Basal antennal article rather slender............. 2

— Eyes with nearly complete, or complete orbits. Basal antennal article very broad....................................61

2 (1) Male abdomen terminally broadened, seventh segment subquadrate and inserted deeply into sixth segment. Male first pleopod longitudinally grooved, with rows of filamentous setae on either side of groove.................... .... Subfamily OREGONIINAE

— Male abdomen not terminally broadened, seventh segment subtriangular and not inserted deeply into sixth segment. Male first pleopod exceedingly varied but not as in Oregoniinae...3

3 (2) Eyes without orbits; eyestalks generally long, either non-retractile, or retractile against an acute postorbital spine affording no concealment. Basal antennal article extremely slender and usually long....Subfamily INACHINAE............4

— Eyes with incomplete or commencing orbits. Basal antennal article not extremely slender..............................24

4 (3) Seven free abdominal segments in male and usually in female...5

— Abdomen of six or fewer segments in both sexes..............15

5 (4) Carapace circular or subcircular. Rostrum appearing trispinose, interantennular spine forwardly projecting and visible from above. Postorbital lobe a prominent spine. Basal antennal article cylindrical. Ambulatory legs very long, the longest more than 3 times carapace length........6

— Carapace pyriform or triangular, never circular. Interantennular spine not visible from above. Postorbital lobe spinous or absent. Basal antennal article flattened. Ambulatory legs variously elongate, never more than $2\frac{1}{4}$ times carapace length..7

6 (5) Interantennular spine projecting well beyond rostrum. Ambulatory propodi flattened, oar-like. Chelipeds not very long, less than 1/3 length of ambulatories in adult male, palm in male inflated, widest about midway along. No long proto-gastric spines....... Platymaia Miers, 1886

Indo-West-Pacific, 6: P. wyvillethomsoni Miers, 1886; medium; in Australia known only from four localities near Eucla, Great Australian Bight (SW); Indo-Malaya, C. Pacific, Japan; lower shelf and slope to 400 fms; further

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distinguished by spine on upper anterior margin of post-orbital lobe (Rathbun) 1918: 7, pls. III, IV, XIV).

— Interantennular spine scarcely, if at all, exceeding rostrum. Ambulatory propodi cylindrical. Chelipeds very long, as long as ambulatories in adult male, palm in male widest distally. Protogastric regions each with a very long, forwardly directed spine... Cyrtomaia Miers, 1886

Indo-West-Pacific, 13: C. maccullochi Rathbun, 1918; medium to large; known only from near Eucla, Great Australian Bight (SW) in 190-450 fms; further distinguished by cylindrical basal segments of antennal flagellum and long rostral spines (Rathbun 1918: 4, figs. 1, 2, pls. 1, 2).

7 (5) Rostrum very short, less than 1/8 postrostral carapace length, of two rounded or blunt lobes. Carapace smooth........... 8

— Rostrum long, at least 1/5 postrostral carapace length, of two acute spines. Carapace with scattered tubercles......10

8 (7) Eyestalks small, retractile beneath edge of carapace. Supra-orbital eave unexpanded, without lobes or spines. Ambulatory legs slender and moderately long, propodi 1 & 2 dilated and compressed, dactyli of all ambulatories subchelate.......... .... Oncinopus de Haan, 1839

Widespread Indo-West-Pacific; monotypic: O. aranea de Haan, 1839 (=O. subpellucidus Stimpson, 1857; O. angulatus Haswell, 1880); small; S, SE, NE, N; littoral to shallow offshore; carapace weakly calcified (Hale 1927: 125, fig. 122; Sakai 1965: 66, pl. 27, fig. 1).

— Eyestalks very long. Supraorbital eave variously expanded. Ambulatory legs variously elongate, cylindrical............ 9

9 (8) Ambulatory legs long, the first twice carapace length, slender. Supraorbital eave unexpanded, lacking lobes or spines. Basal antennal article very slender. Third maxillipeds with merus narrower than ischium.. *Camposcia* Latreille, 1829
Widespread Indo-West-Pacific, monotypic: *C. retusa* Latreille, 1829; medium; NE, N, NW; littoral and sublittoral; often masked by seaweed and sponges (Barnard 1950: 12, fig. 1; Sakai 1965: 69, pl. 30, fig. 1).

— Ambulatory legs short, the first less than 1/4 carapace length, quite stout. Supraorbital eave moderately expanded with a small antorbital lobe; a prominent conical spine between eave and postorbital lobe separated from both by wide fissures. Basal antennal article moderately broad. Third maxillipeds with merus as wide as ischium.. *Arachnotoma* Miers, 1879
Australia, Timor; monotypic: *A. stimpsoni* (Miers, 1879) (=*Paramicippa hispida* Baker, 1905); medium; S, NE, N; littoral (McCulloch 1913: 336, figs. 47, 48).

10 (7) Abdomen showing no coalescence of segments. Orbits with eave unexpanded and unarmed except for a small, widely removed postorbital spine. Ambulatory legs long, cylindrical, first pair more than twice carapace length, stout............................ *Ephippias* Rathbun, 1918

Restricted to Australia, monotypic: E. endeavouri Rathbun, 1918; very large; SE, S, SW, NW; shallow offshore (Rathbun 1918: 9, pl. 15).

— Abdomen sometimes, especially in female, showing coalescence of segments. Orbits with moderately expanded eave followed by one or two spines. Ambulatory legs of only moderate length, less than 1½ carapace length, generally slender, propodi distally expanded, compressed, dactyli subchelate.. .... Naxia Latreille, 1825..........11

Australasia; see reviews by Baker (1905), McCulloch (1913), Balss (1935), Griffin (in press,b);6; all species (except N. deflexifrons) figured by Hale (1927); all except N. spinosa restricted to Australia.

11 (10) Ambulatory propodi weakly expanded distally. Supraorbital eave usually acute anterolaterally..........................12

— Ambulatory propodi strongly expanded distally. Supraorbital eave rounded anterolaterally, armed with a small spine posterolaterally...14

12 (11) Supraorbital eave rounded anterolaterally and with a small spine posterolaterally. Carpus of cheliped smooth......... .... N. deflexifrons (Haswell, 1880)

Medium; SE; shallow offshore (McCulloch 1913: 330, pl. X figs. 1-4).

— Supraorbital eave acute both anterolaterally and posterolaterally. Carpus of cheliped ridged.......................13

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13 (12) Rostral spines stout, almost straight. Carpus of cheliped with lateral ridge rounded.. *N. aurita* (Latreille, 1825) (=*Halimus laevis* Haswell, 1880); large; SW, S, SE; littoral (Hale 1927; 129, fig. 127).

— Rostral spines slender, strongly curved outwards distally. Carpus of cheliped with lateral ridge proximally acute.............................. *N. aires* (Guerin, 1825) (=*Halimus gracilis* Baker, 1905); medium; S, SE; littoral (Hale 1927; 129, fig. 128).

14 (11) Anterolateral spine of basal antennal article laterally denticulate. Merus of cheliped weakly tuberculate dorsally................................ *N. tumida* (Dana, 1851) (=*Halimus tumidus* var *gracilis* Baker, 1905); medium; S, SE, NE; littoral (Hale 1927: 128, fig. 126).

— Anterolateral spine of basal antennal article unarmed. Merus of cheliped smooth......... *N. spinosa* (Hess, 1865) (=*Halimus truncatipes* Miers, 1879); large; SW, S, SE; Kermadecs; littoral (Hale 1927: 127, fig. 125).

15 (4) Abdomen of six segments in both sexes. Carapace triangular...16

— Abdomen of five segments in female, of five or six in male. Carapace subpentagonal to subpyriform.. *Paratymolus* Miers, 1879..........21 Indo-West-Pacific; see also Sakai (1938); 5

16 (15) A prominent postorbital spine. Rostrum generally of moderate length, about 1/3 postrostral carapace length, of two acute

spines. Carapace with a few prominent spines..............
.... *Achaeopsis* Stimpson, 1857.......17
Indo-West-Pacific, Atlantic, Mediterranean; see Sakai (1938);6;
key to species in Griffin (in press,b).

— No postorbital spine. Rostrum very short, less than 1/10 postrostral carapace length, of two generally blunt lobes. Carapace with a few tubercles but not spines...............
..........................*Achaeus* Leach, 1817..............18
Indo-West-Pacific, E. Atlantic, Mediterranean; review of Australasian species in Griffin & Yaldwyn (1965); 20.

17 (16) Rostral spines unarmed. Branchial margins with two prominent spines and a few spinules...........................
..........................*A. thomsoni* (Wyville-Thomson, 1873)
Small; SE, SW; South Africa, E. & W. Atlantic, Mediterranean; lower shelf and slope down to 1000 fms; further distinguished by spinous merus and carpus of cheliped (Hale 1927: 124, fig. 120).

— Rostral spines with 2 or 3 spinules laterally. Branchial margins with four prominent spines.........................
...........................*A. [illegible]* (Baker, 1906)
Small; in Australia known only from off Neptune I. (S), in 104 fms; New Zealand (Hale 1927: 124, fig. 121; Griffin (in press, b, fig.)

18 (16) Rostrum of two short, acute spines. Supraorbital eave bearing laterally a prominent spine and several minute spinules...................*A. fissifrons* (Haswell, 1879)

ap

(=A. tenuicollis Miers, 1886); small; SE; New Zealand, Indo-West-Pacific; shallow offshore and lower shelf (Griffin & Yaldwyn 1965: 38, figs. 1-8).

— Rostrum of two generally rounded lobes. Supraorbital eave sometimes with minute spinules but never with a prominent spine..19

19 (18) Carapace smooth, lacking prominent tubercles. Dactyli of ambulatories 3 and 4 almost semicircular, ventrally spinulated for distal 2/3.......A. lacertosus Stimpson, 1857 (=A. breviceps Haswell, 1880); small; SE, NE, NW; Indo-West-Pacific; sublittoral (Stimpson 1907: 20, pl. III fig. 7).

— Carapace with at least two prominent tubercles on cardiac region. Dactyli of ambulatories 3 and 4 strongly falcate but not semicircular, ventrally spinulated for entire length..20

20 (19) Rostrum of two strong lobes separated by a narrow V or U sinus, often weakly convergent distally. Intestinal region with a small tubercle......A. brevirostris (Haswell, 1879) (=A. affinis Miers, 1884); small; SE, NE, N, NW; Indian O., Indo-Malaya; sublittoral to shallow offshore (Haswell 1880a: 432, pl. XXVII fig. 5).

— Rostrum of two pointed lobes, each with a small, sharp, distal projection. Intestinal region without a tubercle.. ....Achaeus sp.

Known only from a single small female taken off Cairns (NE) in 28 fms (Griffin & Yaldwyn 1965:38).

ap

21 (15) Carapace with protogastric regions each bearing a strong tubercle; branchial margin also with a tubercle or spine...22

— Carapace smooth dorsally and without spines posterolaterally on branchial margin...23

22 (21) Palm of chela dorsally prolonged into a terminal spine. Merus of cheliped with four ventral spines.................
.............................P. _bituberculatus_ Haswell, 1880
(=P. _bituberculatus_ var. _gracilis_ Miers, 1884); very small; restricted to Australia, NE; sublittoral (Haswell 1880c:303, pl. XVI figs 1,2).

— Palm of chela not prolonged into a terminal spine. Merus of cheliped unarmed........P. _nubescens_ Miers, 1879
Very small; N; Indo-West-Pacific; sublittoral to shallow offshore (Miers 1879a: 45, pl. 2 figs 6, 6a,b; Sakai 1965: 66, pl. 26 figs. 3,4).

23 (21) Palm of chela smooth. Merus of cheliped smooth dorsally and with two tubercles ventrally.........................
............................P. _sexspinosus_ Miers, 1884
Very small; NE, N; Indian O., Japan; sublittoral (Miers 1884: 261, pl. XXVII figs, B, b, b^1).

— Palm of chela dorsally spinulous, outer surface with granulations and spinules. Merus of cheliped with numerous spinules dorsally and a few ventrally....................
...........................P. _latipes_ Haswell, 1880
(=P. _latipes_ var. _quadridentata_ Baker, 1906); small; restricted to Australia, SE, S, SW; sublittoral (Hale 1927: 123, fig. 119).

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24 (3) Eyes without true orbits, lacking a postorbital cup. Eye-stalks variously elongate.................................25

— Eyes with commencing orbits having, in addition to the supra-orbital eave which is sometimes produced into a preorbital spine, a large cupped postorbital process into which the eyestalk retracts. Eyestalks short...Subfamily PISINAE...............36

25 (24) Eyestalks long, orbit partially protected by a hornlike supraorbital spine or by a jagged postorbital tooth or by both......................Subfamily OPHTHALMIINAE........26

— Eyestalks short, little moveable and either concealed by a preorbital spine or sunk in sides of rostrum...Subfamily ACANTHONYCHINAE.......29

26 (25) Supraorbital eave hardly expanded and bearing only a small antorbital spine. Rostrum of two weakly curved spines less than 1/3 postrostral carapace length. Branchial margin with small tubercles or unarmed...*Zewa* McCulloch, 1913..........27
Australia, Japan; see McCulloch (1913), Sakai (1938); 4; Australian species, both of which are not known overseas, lack prominent marginal branchial tubercles.

— Supraorbital eave prominently expanded with a strongly developed antorbital spine and/or preorbital spine. Rostrum either of two straight spines 2/3 postrostral carapace length or of two exceedingly short and strongly curved spines. Branchial margins with 2-3 long spines.....................28

ap

27 (26) Postorbital lobe with a strong tubercle. Posterior intestinal margin rounded........Z. varians (Miers, 1879)
Medium; SE, NE, N, NW; sublittoral (Calman 1900:39, pl.2 figs. 25, 26).

— Postorbital lobe without an anterior tubercle. Posterior intestinal margin with a strong medial tubercle............
............................Z. banfieldi McCulloch, 1913
Medium; known only from near Cairns (NE); littoral (McCulloch 1913; 332, pls. X figs. 5,6).

23 (26) Supraorbital eave rounded anteriorly, antorbital spine greatly elongated. Rostral spines widely separated, straight, 2/3 postrostral carapace length. Branchial margins with 3 spines..............Picroceros A. Milne Edwards 1865
N. Caledonia, Lord Howe, N. Hebrides, Japan; monotypic: P. armatus A. Milne Edwards, 1865; very large; NE; sublittoral; further distinguished by single gastric spine and single posterior intestinal spine; carapace spines sometimes knobbed (Sakai 1938: 247, fig. 24; pl. XXV fig. 2).

— Supraorbital eave with strongly developed, subequal preorbital and antorbital spines. Rostral spines arising close together, strongly curved outwards, less than 1/6 postrostral carapace length. Branchial margins with two spines.................
............................Criocarcinus H. Milne Edwards, 1834
Indo-West-Pacific; monotypic: C. superciliosus (Herbst, 1803); large; known in Australia only from Low Isles, Great Barrier Reef (NE) (to be reported elsewhere by F.A. McNeill); littoral

(A. Milne Edwards, 1872: 242, pl. 12 fig. 3; Sakai 1938: 251, text-fig. 26).

29 (25) Rostrum of two spines separate from base. A forwardly produced preorbital spine and a postorbital spine both present. Abdomen in female of 6 or 7 free segments.......30

— Rostrum single or only distally bifid. Preorbital spine present or absent, postorbital spine absent. Abdomen in female of only 5 free segments..............................31

30 (29) Rostrum short, less than 1/4 postrostral carapace length. Branchial margin with a prominent spine or lobe.......................................<u>Pugettia</u> Dana, 1851

Indo-West-Pacific and E. Pacific to California, 13: <u>P. mossica</u> Whitelegge, 1900; small; restricted to Australia, SE; shallow offshore to lower shelf; further distinguished by strongly granulated carapace and dorsally narrow postorbital lobe (Whitelegge 1900: 141, pl. XXXV figs. 5-7).

— Rostrum moderately long, more than 1/3 postrostral carapace length. Branchial margin lacking a lobe or spine.....................................<u>Antilibinia</u> Macleay, 1838

South Africa, Philippines and Australia, 3: <u>A. lappacea</u> Rathbun, 1918; small; known only from Great Australian Bight (SW) near Eucla in 200-300 fms; further distinguished by prominent hepatic spine and length of rostral spines and preorbital spine (Rathbun 1918: 12, fig. 3; pl. vii fig.3).

31 (29) Supraorbital eave with a strong, forwardly directed preorbital spine. Branchial regions, at least, with prominent lateral

ap

expansions. Rostrum slender. Abdomen in male of 7 free segments...32

— Orbit with a weakly expanded eave lacking spines. Margins of carapace weakly expanded. Rostrum a stout 'beak'. Abdomen in male of only 5 free segments..Xenocarcinus White, 1847........35

Indo-West-Pacific, 5; see Gordon (1934), Sakai (1938, 1965); upper orbital margin may be weakly notched once or twice.

32 (31) Rostrum distally acute or bifid, either downwardly deflexed and depressed or horizontal, compressed and vertically deep. Carapace smooth or with only a few (1- 5) tubercles dorsally. Hepatic margin, at least in female, prominently expanded...33

— Rostrum distally acute, horizontal and depressed, vertically shallow. Carapace with numerous scattered tubercles dorsally. Hepatic margin not prominently expanded in either sex.......................................Menaethius H. Milne Edwards, 1834

Widespread Indo-West-Pacific; monotypic: M. monoceros (Latreille, 1825); small; NE, N, NW; Littoral (Barnard 1950: 43, figs. 9 g,h; Sakai 1965: 74, pl. 33 fig. 4).

33 (32) Hepatic expansions well developed in both sexes and separated from branchial expansions by a shallow concavity or closed fissure. Rostrum downwardly deflexed...Sargassocarcinus Ward, 1936

Australia, Philippines and Japan; see Sakai (1965); 2: S. cristatus (Balss, 1924) (=S. foliatus Ward, 1936); small; in Australia known only from Lindeman I., Whitsunday Passage cp

(NE): Japan; littoral; further distinguished by sharply carinate and lobate ambulatory legs (Ward 1936: 9, pl. III figs. 4-6; Sakai 1965: 77, text-figs. 11a, b, pl. 34 fig.3).

— Hepatic expansions well developed in female and clearly separated by a wide fissure from branchial expansions, poorly developed in male. Rostrum horizontal............. .... Huenia de Haan, 1839...........34

Widespread Indo-West-Pacific, 3; species show extreme variation in carapace shape, particularly between sexes.

34 (33) Rostrum distally simple and acute. Branchial expansion rounded, subacute, or sometimes bilobed................... ....H. proteus de Haan, 1839

Medium; S, NW, N; widespread Indo-West-Pacific; littoral, (Hale 1927: 133, fig. 132; Barnard 1950: 41, figs. 9 a-f; Sakai 1965: 75, pl. 34 figs. 1,2).

— Rostrum distally bifid. Branchial expansions bi- or trilobed...................H. bifurcata Streets, 1870

Medium; restricted to Australia, SE; littoral; distally bifid rostrum appears most reliable character (Haswell 1882c: 8); figured here - pl. 1 d,e.

35 (31) Carapace uneven, bearing several very prominent tubercles. Rostrum distally notched. Ambulatory legs smooth......... ....X. tuberculatus White, 1847

Medium; NE; Hong Kong, Japan; littoral and shallow offshore (Sakai 1965: 91, text-fig. 13, pl. 42 fig. 5)

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— Carapace depressed, bearing a few indistinct granules. Rostrum deeply bifid. Ambulatory legs tuberculate.......... ....*X. depressus* Miers, 1874

Small; SE, N; Indo-Malaya, N. Caledonia, Japan; littoral (Gordon 1934: 70, fig. 36 a-d).

36 (24) Intercalated spine present.................................37

— Intercalated spine absent.................................43

37 (36) Abdomen of seven segments in both sexes. Carapace pyriform. Supraorbital eave laterally expanded. Ambulatory legs generally short, seldom more than twice carapace length, usually less.................................38

— Abdomen of seven segments in male, of five in female. Carapace subtriangular. Supraorbital eave almost unexpanded laterally. Ambulatory legs extremely long and slender, the first three times carapace length.......................... ....*Phalangipus* Latreille, 1825.....42

Indo-West-Pacific; Rathbun (1916); 6

38 (37) Rostrum without an accessory spinule. Carapace variously smooth or granular, tuberculate or spinous. Ambulatory legs little longer than carapace.................................39

— Rostrum with an accessory spinule not far from tip. Carapace with well defined granules, spinules and spines. First ambulatory legs at least 1½ times carapace length.......... ....*Naxioides* A. Milne Edwards, 1865...41

Indo-West-Pacific, 9.

ep

39 (38) Carapace broad, smooth or granular. Basal antennal article broad, bearing two strong spines distally, one medial and one lateral.....Herbstia H. Milne Edwards, 1834
E & W central America, S.E. Atlantic, Mediterranean, Australia; see Garth (1958), Rathbun (1918), 10: H. crassipes (A. Milne Edwards, 1873); known only from Bass Strait (SE) in unknown depth; further distinguished by absence of spines on lateral margin of carapace (Haswell 1882: 12, no fig.)

— Carapace narrow, dorsally bearing numerous rounded tubercles. Basal antennal article slender, truncate distally or bearing anterolaterally a lobe or spine............................40

40 (39) Supraorbital eave rounded anterolaterally. Tubercles of carapace arranged in distinct groups. Rostral spines widely separated from base........Eurynome Leach 1817
Indo-West-Pacific, E. Atlantic, Mediterranean; genus reviewed in Griffin (1964), 8-9: E. granulosa Baker 1906; very small; known only from "South Australian coast" in 100-104 fms (Griffin 1965:30, figs. 1-5.)

— Supraorbital eave produced into a strong, forwardly directed spine. Tubercles of carapace scattered. Rostral spines fused basally..............Tylocarcinus Miers, 1879
Widespread Indo-West-Pacific; 2: T. styx (Herbst, 1803); small; N, NE; Indo-West-Pacific; littoral; further distinguished by spinous ambulatory meri and denticulate dactyli (Sakai 1938: 271, pl. XXXVI fig. 5).

ap

41 (38) Rostral spines about 3/4 postrostral length of carapace, divergent from base. Dorsal surface of carapace with numerous tubercles sometimes enlarged into straight spines in mid-dorsal regions......_N. taurus_ (Pocock, 1890)
(?= _N. cerastes_ Ortmann, 1894); small; N; Indian Ocean; shallow offshore (Alcock 1895: 219-20; Alcock & Anderson 1897: pl. XXXIII figs. 2-2a, 5-5a).

— Rostral spines as long as postrostral length of carapace, subparallel basally, weakly divergent distally only. Dorsal surface of carapace with numerous large, curved spines..... ...._N. robillardi_ Miers, 1882
Very large; EF; Mauritius, China S.; shallow offshore (Miers 1882: 339, pl. 20)

42 (37) Median suborbital tooth much deflexed and bounded by a broad U sinus on both sides. Lobe on first abdominal segment in both sexes arcuate and occupying nearly whole width of segment........................_P. australiensis_ Rathbun, 1918
Small; restricted to Australia, known only from Platypus B. (NE) in 7-9 fms; further distinguished by absence of accessory spinule on rostral spines (Rathbun 1918: 15, pl. VI).

— Median suborbital tooth bounded by a V-sinus on both sides. Lobe on first abdominal segment in both sexes small, almost pointed, occupying much less than whole width of segment... ...._P. longipes_ (Linnaeus 1767)
(=_Egeria Aragnoides_ Rumphius, 1705; _E. herbstii_ H. Milne Edwards, 1834;) small; NE, N; Indian Ocean; shallow

ap

offshore; carapace generally prominently spinous (Haswell 1882: 12- no recent fig.)

43 (36) Abdomen of seven segments in both sexes. Rostral spines generally distinct from base. Carapace with slender spines or tubercles. Ambulatory legs generally long, if short then carapace weakly tuberculate.................................44

— Abdomen in male of seven segments, of five segments in female. Rostral spines basally coalescent. Carapace with stout spines, ambulatory legs short or carapace with slender spines, ambulatory legs long.................................60

44 (43) Rostral spines slender, in length at least 1/6 postrostral portion of carapace and usually longer. Supraorbital eave not in close contact with postorbital lobe..................45

— Rostral spines stout, in length less than 1/6 postrostral portion of carapace. Supraorbital eave separated from postorbital lobe by an extremely narrow fissure or completely coalesced with it.......................................59

45 (44) Supraorbital eave rounded anterolaterally and posterolaterally. Carapace completely smooth...Micippoides A. Milne Edwards, 1873 Widespread Indo-West-Pacific; monotypic: M. angustifrons A. Milne Edwards, 1873 (=Hyastenus andrewsi Calman, 1909); small; E. New Guinea; littoral; further distinguished by weakly denticulate ambulatory dactyli, body and legs covered by very long hair (Calman 1909: 711, pl. LXII figs. 6,7).

— Supraorbital eave at least anterolaterally acute, sometimes produced into a preorbital spine. Carapace with several prominent spines and/or tubercles or else granular.........46

46 (45) Supraorbital eave separated from postorbital lobe by a broad U sinus, posterolaterally unarmed, anterolaterally armed with a strong preorbital spine. Rostral spines fused for a short distance basally. Basal antennal article distally truncate.. ....<u>Rochinia</u> A. Milne Edwards, 1875
Indo-West-Pacific and E. Pacific, Atlantic and Mediterranean; see Garth (1958); 18: <u>R. fultoni</u> (Grant, 1905) n. comb.; medium; restricted to SE Australia; lower shelf and slope to 300 fms; further distinguished by 1 medial gastric, 1 medial cardiac, 1 medial intestinal and 1 lateral branchial spine (Rathbun 1918: 14, pl. V).

— Supraorbital eave posterolaterally acute, separated from postorbital lobe by a wide V or sometimes U sinus, anterolaterally acute but seldom produced. Rostral spines separated from base. Basal antennal article with an anterolateral spine or lobe..............<u>Hyastenus</u> White, 1847............47
Tropical Indo-Pacific; list of species in Balss (1935):38.

47 (46) Denuded carapace with dorsal surface bearing numerous tubercles or spines and erosions..............................48

— Denuded carapace with a few spines or tubercles, often smoothly polished..49

48 (47) Rostral spines as long as postrostral portion of carapace. Surface of carapace eroded but indistinctly tuberculate.......................................*H. sebae* White, 1847

Small; N, NW; Indian O., Indo-Malaya; sublittoral (Alcock 1895: 213); figured here - pl. 1 b,c.

— Rostral spines about ½ postrostral carapace length. Surface of carapace distinctly tuberculate..*H. oryx* A. Milne Edwards, 1872

Medium; NE, N, NW, SW; Indian O., Indo-Malaya; sublittoral to shallow offshore (A. Milne Edwards 1872: 250, pl. XIV fig. 1; Haswell 1882:20).

49 (47) Rostral spines less than 1/5 postrostral portion of carapace..50

— Rostral spines at least 1/3 postrostral carapace length and generally longer..52

50 (49) Gastric regions with three medial tubercles; a prominent medial tubercle on cardiac region and on posterior intestinal margin; dorsal surface otherwise with several tubercles laterally..................*H. verrucosipes* (Adams & White,1848)

Small; in Australia known only from Torres Strait in 15-20 fms; Indo-Malaya (Calman 1900: 36, pl. 2 figs. 23,24).

— Gastric region with a single tubercle medially, dorsal surface otherwise with some tubercles laterally but none mid-dorsally..51

51 (50) Rostral spines outwardly curved distally...*H. minimus* Rathbun, 1924

ap

Very small; restricted to Australia, known only from C. Jaubert (NW) in 5-7 fms. (Rathbun 1924: 4, fig. 1).

— Rostral spines subparallel, weakly curved inwards distally.. ...._H. planasius_ (Adams & White, 1848)

Medium; in Australia known only from Pt. Denison (NE); New Guinea, Indian O., Indo-Malaya; shallow offshore (Adams & White, 1848: 9, pl. ii figs. 4,5: Alcock 1895: 212).

52 (49) Branchial regions with a spine close to lateral margin, at widest part of carapace, markedly longer than any other spine or tubercle except rostral spines..........................53

— Branchial regions with a small tubercle or spine close to lateral margin, at widest part of carapace, little longer than other tubercles of carapace..........................55

53 (52) Gastric regions with two medial tubercles or spines, cardiac region with a central tubercle. Rostral spines sinuous.... ...._H. spinosus_ A. Milne Edwards, 1872

Large; in Australia known only from Torres Strait in 5-7 fms; South Africa, Fiji (Barnard 1950: 53, fig. 11f).

— Gastric regions with a single medial tubercle; cardiac region without a tubercle. Rostral spines straight........54

54 (53) Intestinal region without a tubercle. Lateral branchial spine without a subdorsal tubercle in front of it.......... ...._H. diacanthus_ (de Haan, 1839)

Large; SE, NE, N, NW, SW; widespread Indo-West-Pacific sublittoral to shallow offshore; rostrum in female often

ap

shorter than in male, lateral branchial spine often greatly reduced, abdomen of female of 5 segments (Alcock 1895: 210; Sakai 1965: 81, pl. 36 fig. 1).

— Intestinal region with a strong tubercle. Lateral branchial spine with a tubercle above and in front of it.. *H. auctus* Rathbun, 1916

Small; in Australia known only from near C. Jaubert (NW) in 12-14 fms; Philippines (Rathbun 1916: 543); figured here -pl.1a

55 (52) Carapace strongly tuberculate. Rostral spines almost as long as postrostral carapace length.. *H. brockii* de Man, 1888

Medium; in Australia known only from Torres Strait (N); Indian O., Indo-Malaya; sublittoral (de Man 1888: 221, pl.7 fig. 1).

— Carapace weakly tuberculate or granular or sometimes smooth. Rostral spines usually ½ postrostral carapace length, sometimes longer.. 56

56 (55) Rostral spines 2/3 postrostral carapace length. A single medial gastric tubercle and several granules laterally.. *H. borradailei* (Rathbun, 1907).

Medium; in Australia known only from C. Jaubert (NW); Indo-West-Pacific; sublittoral to shallow offshore; further distinguished by 5 gastric granules in a transverse row, body covered by a thick tomentum (Rathbun 1911: 251, pl.20 fig. 5).

ap

— Rostral spines ½ postrostral carapace length. Carapace with gastric and intestinal tubercles medially or else smooth...57

57 (56) Carapace completely smooth except for lateral branchial tubercle. Supraorbital eave produced as a blunt forwardly directed spine.............<u>H</u>. <u>irami</u> (Laurie, 1906)

Very small; in Australia known only from C. Jaubert (NW); Ceylon; sublittoral (Laurie 1906: 379, pl. 1 figs. 4,4a)

— Carapace with at least a trace of 1 or 2 medial tubercles in gastric, cardiac and intestinal regions. Supraorbital eave acute anteriorly but not forwardly produced..........58

58 (57) Rostral spines curved slightly outwards distally. Branchial regions with 2-3 small tubercles laterally including that at widest part of carapace....<u>H</u>. <u>convexus</u> Miers, 1884

Small; NE, N, NW; Indian O., Indo-Malaya; sublittoral to shallow offshore (Miers 1884: 196, pl. XVIII figs. B,b)

— Rostral spines curved slightly inwards distally. Branchial regions completely smooth laterally except for small spine at widest part of carapace...<u>H</u>. <u>espinosus</u> Borradaile, 1903

Small; in Australia known only from C. Jaubert (NW); Maldive Archipelago; sublittoral (Borradaile 1903: 688, pl. XLVII figs. 4a-d).

59 (44) Carapace armed with several prominent tubercles and generally a few spines. Supraorbital eave and postorbital lobe separated by a narrow fissure. Ambulatory legs smooth.... ....<u>Doclea</u> Leach, 1814

Tropical Indo-Pacific, 13: <u>D</u>. <u>profunda</u> Rathbun, 1918; small;

known only from a single ovigerous female taken in Great Australian Bight, south (SW) of Eucla, in 250-450 fms; further distinguished by single cardiac and intestinal spine and single hepatic and branchial marginal spines, narrowly pyriform carapace unusual for this genus (Rathbun 1918: 16, pl. VII figs. 1,2).

— Carapace unevenly and indistinctly tuberculate, lacking spines. Supraorbital eave completely fused with postorbital lobe. Ambulatory legs armed with a few spines and tubercles.. ....<u>Perinia</u> Dana 1851

Widespread Indo-West-Pacific, monotypic: <u>P. tumida</u> Dana, 1851 (=<u>Parathoe rotundata</u> Miers, 1879); very small; NE; littoral; further distinguished by short, broad, apically inwardly curved rostral spines and denticulate dactyli (Miers 1879b: 16, pl. V fig. 2, 2a; Sakai 1938: 294, fig. 40).

60 (43) Supraorbital eave well expanded posterolaterally, separated from postorbital lobe by an extremely narrow fissure. Rostrum bifid for distal half only. Carapace armed with a few slender spines. Ambulatory legs long, the first at least twice carapace length, slender, smooth.................................. ....<u>Austrolibinia</u> n. gen.

India, New Guinea, Australia, 2: <u>A. gracilipes</u> (Miers, 1879) n. comb.; small: NE, N, NW; New Guinea; shallow offshore; further distinguished by 2 medial gastric and 1 medial cardiac spine, a broad, acute intestinal lobe and 2 dorsal branchial spines (Miers 1879b: 7, pl. IV figs. 4, 4a).

— Supraorbital eave weakly expanded posterolaterally, separated from postorbital lobe by a wide U sinus. Rostrum less than 1/6 postrostral carapace length, bifid for at least distal 2/3. Carapace armed with numerous, short, very coarse spines. Ambulatory legs little longer than carapace, stout, spinous..................<u>Hoplophrys</u> Henderson, 1893

Tropical Indo-West-Pacific; see Alcock (1895), Sakai (1932), Buitendijk (1939); 2: <u>H. ogilbyi</u> McCulloch, 1908; small; in Australia known only from Moreton B. (NE); Indo-Malaya (Moluccas, Ceram),? Japan; sublittoral; further distinguished by simple spine at lateral branchial angle (McCulloch 1908: 51, pl. xii fig. 2,2a)

61 (1) Basal antennal article not specially expanded to form a floor to the orbit, which is formed by a supraorbital eave, a postorbital lobe and an intercalated spine between the two..........................Subfamily MAJINAE.................62

— Basal antennal article expanded to form a floor to the orbit which is formed by eave and postorbital lobe; intercalated spine present or absent....Subfamily MITHRACINAE............81

62 (61) Postorbital lobe a simple acute spine more or less isolated from orbit and affording no concealment to cornea of eyestalk.63

— Postorbital lobe cupped, close to orbit and affording some concealment to cornea of retracted eyestalk..................66

63 (62) Rostral spines shorter than width at base, fused for basal 1/3. Postorbital spine no longer than intercalated spine. Basal antennal article slightly narrowed anteriorly, lateral

margin notched distally. Carapace very weakly tuberculate.
..........................*Paramithrax* H. Milne Edwards, 1834
Restricted to Australia, monotypic: *P. barbicornis* (Latreille, 1825) (=*Gonatorhynchus tumidus* Haswell, 1880); medium; SW, S, SE; littoral to shallow offshore; further distinguished by two small marginal branchial tubercles (Griffin 1963b: 137, figs. 7-14).

— Rostral spines longer than their width at base, distinct from base. Postorbital spine distinctly longer than intercalated spine. Basal antennal article of even width throughout, or produced into a lobe anterolaterally, not notched laterally or narrowed distally. Carapace spinous or densely tuberculate.
....64

64 (63) Chelipeds in adult male robust, merus tuberculate or spinous, carpus with a dorsal and lateral longitudinal ridge. Eyestalks not especially slender and hardly reaching postorbital spine....................*Notomithrax* Griffin, 1963.........65
South Pacific to Juan Fernandez; review of species in Griffin (1963a); 5

— Chelipeds in both sexes slender and unarmed, carpus subcylindrical, lacking ridges. Eyestalks long and slender, reaching postorbital spine...*Maja* Lamarck, 1801
Tropical Indo-West-Pacific, E. Atlantic & Mediterranean, 15: *M. miersii* Walker, 1890; large; in Australia known only from C. Jaubert (NW): Singapore, Japan; sublittoral to

shallow offshore; further distinguished by 2 medial and 5 marginal spines (Sakai 1938: 298, pl. XXXVIII fig. 2)

65 (64) Carapace with both spines and tubercles dorsally. Hepatic margin with two spines, branchial margin with seven spines.. ....*N. minor* (Filhol, 1885) (=*Paramithrax peronii*; Haswell, 1882); large; SE, NE, New Zealand; sublittoral to lower shelf; further distinguished by spines of branchial margin being alternately large and small; usually thickly covered by algae, hydroids and sponges (Rathbun 1918: 18, pl. VIII)

— Carapace with numerous low tubercles dorsally. Hepatic and branchial margins each with three spines.................... ....*N. ursus* (Herbst, 1788) (=*Paramithrax latreillei* Miers, 1876); large; SE; New Zealand; littoral; hepatic and branchial marginal spines decrease in size posteriorly, body thickly hirsute (Griffin , in press, b, fig.).

66 (62) Postorbital lobe sometimes with spines or tubercles on posterior edge but not on anterior upper edge................67

— Postorbital lobe with a prominent accessory spine on upper anterior edge near base....................................78

67 (66) Supraorbital eave seldom with a preorbital spine. Rostral spines straight but divergent, seldom more than 1/6 post-rostral portion of carapace in length. Carapace densely tuberculate, margins spinous. Chelipeds with merus and

carpus variously tuberculate..............................
..........................*Leptomithrax* Miers, 1876..........68
Australasia, Indo-Malaya, Japan; review of Australian and New Zealand species in Griffin (in press,b); 16; all Australian species except *L. tuberculatus* restricted to Australia.

— Supraorbital eave with a prominent preorbital lobe directed outwards or upwards. Rostral spines straight and divergent, or, more usually, outwardly curved distally, in length at least 1/4 postrostral portion of carapace. Carapace with a few scattered long or short spines or lamellae, otherwise smooth. Chelipeds with merus and carpus smooth or with well-developed longitudinal crests..........................
..........................*Chlorinoides* Haswell, 1880........73
Indo-West-Pacific; reviewed in detail in Griffin (in press, a); 12

68 (67) Intercalated spine not nearly reaching tip of antorbital spine, almost excluded from outer rim of supraorbital margin by distal approximation of antorbital spine and postorbital lobe. Ambulatory legs hardly longer than carapace..........69

— Intercalated spine reaching to tip of antorbital spine, not excluded from rim of supraorbital margin. Ambulatory legs at least 1½ times carapace length............................71

69 (68) Sternum and abdomen smooth in adults and juveniles of both sexes. Carapace weakly tuberculate. Two marginal branchial spines.....................*L. parvispinosus* (Ward, 1933)
Medium; SE, NE; littoral; orbit becomes slightly more

open in larger specimens (Ward 1933: 392, pl. XXIII fig. 4)

— Sternum or abdomen, or both, excavated as rimmed pits in adult males and juveniles. Carapace strongly tuberculate. Three or four marginal branchial spines....................70

70 (69) Postorbital lobe acuminate. Four marginal branchial spines.. ....L. tuberculatus (Whitelegge, 1900)
Medium to large; SE; New Zealand, Kermadecs; shallow offshore to lower shelf; Australian forms with short marginal and long dorsal spines (Whitelegge 1900: 146, pl. XXXIV figs. 1,2)

— Postorbital lobe truncate distally. Three marginal branchial spines............L. sternocostulatus (H.Milne Edwards, 1851)
Medium to large; S, SE, NE, NW; shallow offshore; further distinguished by sternal excavations being wholly segmental (Hale 1927: 137, fig. 137)

71 (68) Carapace narrowly pyriform, width no more than 3/4 post-rostral length. Postorbital lobe distally slender with a single small spinule close to tip and numerous small tubercles around base. First ambulatory leg twice carapace length....................L. globifer Rathbun, 1918
Large to very large; SW; lower shelf and slope to 120 fms; (Rathbun 1918: 23, pls. X, XI)

— Carapace broadly pyriform, at least in adult, width at least 2/3 postrostral length. Postorbital lobe subtriangular, distal portion not especially slender, a prominent spine or tubercle close to tip and another about halfway along posterior edge. First ambulatory leg no more than $1\frac{1}{2}$ times carapace length.. 72

72 (71) Mid-dorsal regions of carapace thickly covered by both spines and tubercles. Ambulatory meri with a blunt terminal dorsal lobe.......................L. gaimardii (H.Milne Edwards,1834) (=L. australiensis Miers, 1876; L. spinulosus Haswell, 1880); very large; SW, S, SE; sublittoral to slope down to 450 fms; postorbital lobe with sharp spinules in juvenile and blunt tubercles in adult (Hale 1927: 135, fig. 135; Griffin 1963b: 133, figs. 1-6, pls. 6,7).

— Mid-dorsal regions of carapace smooth except for a few short, prominent spines. Ambulatory meri with a prominent sharp terminal dorsal spine......L. waitei (Whitelegee, 1900). Very large; SE; shallow offshore to lower shelf; postorbital lobe with sharp accessory spines in juveniles and adults (Whitelegge 1900: 143, pl. XXXIII).

73 (67) Preorbital lobe vertically directed upwards from base. Carapace with a few long spines but no lamellae. Rostral spines with a small spinule on dorsal surface near tip....... ....C. tenuirostris Haswell, 1880 Medium; restricted to Australia; NE, N; shallow offshore (Griffin, in press, a, fig.).

— Preorbital lobe outwardly directed, at least basally. Carapace with a few spines and some lamellae, particularly around margins and above orbit. Rostral spines without a spinule on dorsal surface... 74

74 (73) Rostral spines straight, divergent, distal width less than twice basal width. Branchial margins with three spines and, anteriorly, a small lamellae. Ambulatory legs with numerous prominent tubercles dorsally arranged in rows.. ....C. goldsboroughi Rathbun, 1906

Medium; in Australia known from 2 specimens taken off N.S.W. coast in 70-120 fms; Hawaii (Rathbun 1906: 881, pl. XIV fig. 7)

— Rostral spines weakly or strongly outwardly curved, very divergent, distal width at least $2\frac{1}{2}$ times basal width. Branchial margins with two spines posteriorly. Ambulatory legs smooth or minutely spinous..............................75

75 (74) Antorbital lobe a narrow, flattened, distally rounded lamella, preorbital lobe much wider and somewhat longer. Rostral spines weakly curved.......................................76

— Antorbital and preorbital lobes subequal, acuminate. Rostral spines very strongly curved outwards distally...............77

76 (75) Preorbital lobe simple, acuminate. Rostral spines unarmed. Posterior intestinal margin with a short, cylindrical spine. ....C. albanyensis (Ward, 1933)

Medium; restricted to Australia, NE; sublittoral to shallow offshore (Ward 1933: 391, pl. XXIII fig. 3).

— Preorbital lobe wide distally, truncate or bifid. Rostral spines armed with several strong spines medially. Posterior intestinal margin with a wide, flattened lamella............. ....C. spatulifer (Haswell, 1882)

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(=Acanthophrys aculeatus A. Milne Edwards, 1865); medium; restricted to Australia, SW, S, SE; sublittoral to slope down to 250 fms (Hale 1927: 137, fig. 138).

77 (75) Preorbital spine simple. A single cardiac spine. Intestinal region with two medial spines.................................. ....C. aculeatus (H.Milne Edwards,1834) (=Acanthophrys aculeatus var. armatus Miers, 1884); large; NE, N, NW; Indian O., Japan; sublittoral to lower shelf (Miers 1884: 193, pl. XVIII, fig. A)

— Preorbital lobe divided into two distinct spines. Cardiac region with a pair of widely divergent, outwardly curved spines. Intestinal region with a single spine............... ....C. longispinus (de Haan, 1839) (=Paramithrax coppingeri Haswell, 1880); large; SE, NE, NW; widespread Indo-West-Pacific; shallow offshore (Sakai 1965: 87, pl. 40 fig. 1).

78 (66) Carapace suborbicular. Rostrum exceedingly short, 1/8-1/20 postrostral carapace length, unarmed.......................... ....Cyclax Dana, 1851.................79 Widespread Indo-Pacific; detailed account in Forest & Guinot (1961); 2.

— Carapace pyriform. Rostrum of moderate length, more than 1/5 postrostral carapace length, bearing one or two spines or tubercles laterally near base........................... ....Schizophrys White, 1847........80 Widespread Indo-West-Pacific; 2.

ap

— Carapace pyriform. Rostrum of moderate length, more than 1/5 postrostral carapace length, bearing one or two spines or tubercles laterally near base..Schizophrys White, 1847.........80
Widespread Indo-West-Pacific; 2.

79 (78) Intercalated spine distally with three subequal spinules. Basal antennal article with a strong accessory spine between anterolateral and anteromedial spines. Marginal spines of carapace granular almost to tip..C. suborbicularis (Stimpson, 1858)
(=Cyclomaia margaritata A. Milne Edwards, 1872); SW, NW; Seychelles to Tahiti; littoral (Forest & Guinot 1961: 15, figs. 5, 6, 10; pl. VI figs. 1,2)

— Intercalated spine triangular, granulate basally only. Basal antennal article lacking an accessory spine between main anterior spines. Marginal spines of carapace granular only at their bases.............C. spinicinctus Heller, 1861
Medium; SW, N, NE; E. Africa to Samoa; littoral (Forest & Guinot 1961: 15, figs. 7, 8, 11; pl. VI, fig. 3)

80 (78) Rostrum with a single lateral spine. Surface of carapace bearing a few groups of prominent tubercles, especially posteriorly and several spines..S. aspera (H. Milne Edwards, 1834)
Large; S, NE, N, NW, SW; widespread Indo-West-Pacific; littoral (Hale 1927: 134, fig. 139); also figured here - pl. 2a,b.

— Rostrum with two lateral spines or tubercles. Surface of carapace densely covered by low tubercles dorsally.........
..........................*S. dama* (Herbst, 1804)
Large; SW, NW; Indo-Malaya; littoral (Yaldwyn, 1964, fig.)

81 (61) Intercalated spine present.................................82

— Intercalated spine absent (possibly present in *Paranaxia*)....88

82 (81) Rostrum weakly deflexed, of two slender spines distinct from base......................*Entomonyx* Miers, 1884
Indian O., Japan; monotypic: *E. spinosus* Miers, 1884 (=*Acanthophrys spinosus*: Balss, 1929); small; in Australia known only from Dampier I. (NW); shallow offshore and lower shelf; further distinguished by two marginal branchial spines and densely tuberculate chelipeds (Miers 1884:526, pl. XLVII fig. B; Sakai 1965: 88, pl. 40 fig. 2).

— Rostrum generally steeply deflexed, broad, lamellar, of two spines fused for at least basal third.........................
.........................*Micippa* Leach, 1817...............83
Tropical Indo-Pacific; see Miers (1885), Sakai (1938), Buitendijk (1939); 8.

83 (82) Eyestalks projecting laterally well beyond postorbital lobe. Rostrum of two distally distinct, truncate lobes............
.........................*M. tuberculosa* (H. Milne Edwards,1834
(=*Micippa parvirostris* Miers, 1879); small; restricted to Australia, S, SE; littoral; further distinguished by 4 large marginal branchial spines and broad antennal flagellum (Hale 1927: 140, fig. 142).

— Eyestalks reaching only to postorbital lobe. Rostrum of two acute spines, or distally notched....................84

84 (83) Rostrum terminating in two strong submedial lobes flanked by a short, broad, recurved spine. Carapace strongly tuberculate and lacking spines dorsally..................85

— Rostrum distally bifid or notched, without lateral spines. Carapace smooth or granular with a few tubercles or strongly tuberculate and spinous..................................86

85 (84) Orbit open below, a wide hiatus between smooth basal antennal article and postorbital lobe. Anterolateral borders of carapace with 8-10 spines, anterior spines broad, posterior spines acuminate...........*M. platipes* Rüppell, 1830 (=*M. spatulifrons* A. Milne Edwards, 1872); small to medium; NE; widespread Indo-West-Pacific; littoral and sublittoral (Sakai 1938: 316, fig. 46; pl. XXXII fig. 2; pl. XXXVIII fig. 4; Buitendijk 1939: 254, text-fig. 22, pl. X figs. 2,4).

— Orbit closed below, strongly tuberculate basal antennal article in broad contact with postorbital lobe. Anterolateral borders with 3-6 acuminate spines or spinules...*M. philyra* (Herbst, 1803) (=*M. superciliosa* Haswell, 1880; *Paramicippa asperimanus* Miers, 1884; *M. mascarenica* var. *nodulifera* Baker, 1905); medium; SW, NW, N,S; widespread Indo-West-Pacific; littoral and sublittoral (Haswell 1880a: 446, pl. 26 figs. 2, 2a; Buitendijk 1939: 253, text-fig. 21, pl. X figs. 1,3; Sakai 1965: 90, pl. 42, fig. 1).

86 (84) Rostrum of two, outwardly curved, sharply pointed spines, distinct for distal half...M. thalia (Herbst, 1803) (=M. inermis Haswell, 1880); SW, N, NE; widespread Indo-West-Pacific; medium; sublittoral to shallow offshore; further distinguished by 2 medial gastric, 2 submedial cardiac, 1 dorsal branchial and 9 marginal branchial spines (Haswell 1880a; 445 pl. 26 figs. 3,3a; Sakai 1965: 90, pl. 42 fig. 3)

— Rostral spines fused throughout their length..............87

87 (86) Carapace minutely granular dorsally with a few tubercles, anterolateral margins with about 3 small spinules. Merus of cheliped dorsally carinate; ambulatory legs tuberculate.................................M. curtispina Haswell, 1880 Small; NE, N; Singapore; sublittoral; further distinguished by basally vertically deflexed and apically inflexed rostrum (Haswell 1880a: 446, pl. 25 figs. 1, 1a).

— Carapace strongly tuberculate and spinous, anterolateral margins with about 9 prominent spines of various sizes. Merus of chelipeds smooth; ambulatory meri smooth except for a terminal dorsal spine..M. spinosa (Stimpson, 1857) (=Paramicippa affinis Miers, 1879); medium; restricted to Australia, S, SE; sublittoral and shallow offshore (Hale 1927: 140, fig. 143)

88 (81) Supraorbital eave separated from postorbital lobe by a wide fissure, not expanded anteriorly into a preorbital spine or lobe. Rostral spines short, broad..........................

ap

..........................*Tumulosternum* McCulloch, 1913

Restricted to Australia; monotypic; *T. longimanus* Haswell, 1880); medium; SE; littoral (Haswell 1880a: 444, pl. XXVI; McCulloch 1913: 334, fig. 45)

— Supraorbital eave separated from postorbital lobe by a very narrow fissure or completely unexpanded posterolaterally, armed with a prominent preorbital spine or lobe. Rostral spines moderately to very long.............................89

89 (88) Rostrum of two distinct, subparallel spines, each apically bifid. Basal antennal article narrowed anteriorly. Carapace weakly tuberculate. Ambulatory legs smooth.................

........................*Paranaxia* Rathbun, 1924

Restricted to Australia; monotypic: *P. serpulifera* (Guérin, 1829); very large; SW, NW, N; sublittoral to shallow offshore (Rathbun 1924: 7, Montgomery 1931; 417); figured here - pl. 3a.

— Rostrum of two spines, contiguous throughout their length or at most only apically divergent. Basal antennal article with anterolateral angle forwardly produced. Carapace with groups of distinct or confluent tubercles dorsally. Ambulatory legs tuberculate....*Tiarinia* Dana, 1851............90

Tropical Indo-West-Pacific; see Stimpson (1907), Sakai (1938), Buitendijk (1939); 6.

90 (89) Rostrum with two or three lateral spines close to base. Carapace bearing numerous coarse tubercles dorsally..........

........................*T. angusta* Dana, 1851

Indo-Malaya, Japan; littoral; further distinguished by 3

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— Rostrum unarmed. Carapace smooth, uneven, or with distant tubercles...91

91 (90) Rostrum moderately long, about 1/3 postrostral portion of carapace..................*T. elegans* Haswell, 1882

Medium; known only from off Broughton I., Pt. Stephens (SE) in 25 fms; further distinguished by 2-3 conical submarginal branchial tubercles (Haswell 1882c: 29); figured here - pl. 3b.

— Rostrum short, less than 1/5 postrostral portion of carapace...92

92 (91) Carapace with distinct erect tubercles and granules dorsally, branchial region with six obtuse tubercles laterally....................................*T. cornigera* (Latreille, 1825)

(=*T. mammillata* Haswell, 1880); medium to large; NW; Indian O., Indo-Malaya, Japan; littoral; carapace very wide - width equal to postrostral length (Sakai 1965: 91, pl. 42 fig. 2; Buitendijk 1939: pl. XI fig. 1)

— Carapace with confluent depressed tubercles or smooth dorsally, branchial regions with five, or fewer, acute tubercles laterally...93

93 (92) Branchial regions with five large tubercles laterally. Preorbital spine quite stout. Seventh abdominal segment in male wider than long.......*T. gracilis* Dana, 1852

(?=*T. depressa* Stimpson, 1857); medium; SE, NE; Indo-Malaya Japan; littoral; further distinguished by 3 large, subequal, blunt tubercles on posterior margin (Stimpson 1907: 12, pl. III fig. 2; Sakai 1938: 321, fig. 49; Buitendijk 1939: 259, text-fig. 26, pl. XI fig. 2)

— Branchial regions with a single sharp spine at widest part of carapace laterally. Preorbital spine very slender. Seventh abdominal segment in male much longer than wide...... ....*T. tiarata* (Adams & White, 1848) Small; N. Guinea; West-Pacific; sublittoral; further distinguished by completely straight rostral spines (Sakai 1938: 322, pl. XXXVIII fig. 7).

VII. ZOOGEOGRAPHY

Two features of the Australian majid fauna stand out: 1) the relatively large proportion of species (31%) which have been recorded only once from a single locality in Australia; and 2) the very clear partitioning of the fauna into tropical and temperate components.

Of the poorly known species, 12 are not known outside Australia whilst 16 are very widely distributed species known from several parts of the Indo-West-Pacific. Ten of the species were recorded by Rathbun, either from the Endeavour collections or from near Cape Jaubert (Rathbun 1918; 1924), two were recorded by Whitelegge (1900) and two by Baker 1905; 1906). Fewer species have been recorded from Western Australia than from eastern coasts.

The geographical boundaries between the tropical and temperate faunas are in the form of very broad transition areas (containing a mixture of tropical and temperate species) extending from Shark Bay to Fremantle on the west coast and from about Mast Head Island to Cape Howe on the east. Slightly narrower transition areas between south-eastern and south-western provinces on the one hand and between


Schizophrys aspera
Oncinopus aranea
Hyastenus diacanthus
Paranaxia serpulifera
Leptomithrax sternocostulatus
Chlorinoides spatulifer
Achaeus fissifrons
Naxia aurita

TEXT-FIG. 3 Known Australian distribution of eight species of majid spider crab. (Each circle represents a single recorded locality).

north-eastern and north-western provinces on the other, appear to exist just west of Kangaroo Island in the south and around Torres Strait in the north. The four faunal provinces which emerge here are in general agreement with the findings of workers on other groups of marine animals (see Bennett & Pope 1953). Two points should be mentioned here; 1) the Spencer Gulf area of South Australia shows a very close affinity with the rest of south-eastern Australia but possesses five species which are tropical and not otherwise known from temperate latitudes (Oncinopus aranea, Anacinetops stimpsoni, Huenia proteus, Schizophrys aspera and Micippa philyra); 2) the Torres Strait fauna is a mixture of species otherwise known from north-eastern and to a lesser extent north-western, Australia with very few species confined to the region.

The tropical fauna is clearly part of that of the Indo-West-Pacific and possesses few species restricted to Australia. The first feature is borne out most strikingly by the fact that a larger proportion of it is shared with other Indo-West-Pacific areas than with temperate Australian provinces. Thus, of the north-eastern species only 18% extend southward compared with 50% which are shared with the Indian Ocean, 47% with Japan and 36% with Indo-Malaya. Similarly, for the north-western fauna, 28% extend southward whereas 72% are shared with the Indian Ocean, 48% with Japan and 60% with Indo-Malaya. However, the proportion of species which are distributed throughout the Australian tropical is not very high. For example 42% of the species found in north-eastern Australia are shared with north-western Australia and the proportion falls to 29% if Torres Strait is excluded. Indian Ocean species are represented to approximately equal extents (about 60%)

in both the north east and north west but the Japanese species are definitely best represented in the north east (also about 60%). Widespread Indo-West-Pacific species which are also widely distributed in the Australian tropics include Oncinopus aranea, Menaethius monoceros, several species of Hyastenus, Schizophrys aspera, two species of Chlorinoides, three of Micippa and two of Tiarinia.

The low degree of restriction in the tropical fauna is evidenced by fewer than 30% of the species in either of the tropical provinces which are not found outside Australia and about 30% which are restricted to any one province. Restricted Australian species found in the tropics include species of Zewa, Hyastenus minimus, Phalangipus australiensis and two species of Chlorinoides.

The temperate provinces contain fewer species and overall there is a much greater restriction of these species both to Australia and to particular provinces. Thus, only nine species are found in both south-western and south-eastern Australia out of a total of 34 south-eastern and 20 south-western species; 40% of the south-eastern and 50% of the south-western species are not known outside Australia. Eight species appear to be widespread temperate forms (two species of Naxia, Ephippias endeavouri, Paratymolus latipes, two species of Leptomithrax and Chlorinoides spatulifer). The relationships of the temperate species are either with tropical Australia (e.g., species of Paratymolus, Zewa, Huenia, Xenocarcinus, Hyastenus, Chlorinoides and Micippa) or with the Indo-West-Pacific (e.g. species of Achaeopsis, Platymaia, Cyrtomaia, Pugettia, Doclea, Eurynome and Leptomithrax). The relationships with temperate regions outside Australia are slight. Only one species which

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does not have a tropical distribution, Achaeopsis thomsoni, is shared with South Africa. Five species, all of which are found in south-eastern Australia, are shared with New Zealand. Of the nine genera shared with New Zealand, seven are more or less widespread in the Indo-West-Pacific. The strong restricted element in the Australian temperate fauna is exemplified by species of Naxia, Ephippias endeavouri, Paramithrax barbicornis and Tumulosternum longimanus. Of the 37 species restricted to Australia, 69% are temperate.

If only species which penetrate the transition zones between tropical and temperate regions are considered, there is indeed only a very slight partitioning of the fauna into eastern and western elements. Such eastern species probably number no more than six (e.g. Naxia tumida and Notomithrax minor) and western ones no more than five (e.g. Paranaxia serpulifera and Schizophrys dama). If more steno-thermal species are considered a division between eastern and western regions is quite clear.

Distant relationships of the fauna are shown, at the specific level, by nine species shared with South Africa, 10 with the Red Sea and eight with Hawaii; one species, Achaeopsis thomsoni, is also found in the Atlantic. The vast majority of these widespread species are represented in the tropical fauna of Australia.

The zoogeographical features shown by the species are strongly emphasized at the generic level. Thus 58% of the 43 genera have wide-spread tropical Indo-West-Pacific representation. A further 16%, also represented in the Indo-West-Pacific, have wider relationships, four genera (Achaeus, Achaeopsis, Eurynome and Maja) being found in the Atlantic and three (Pugettia, Herbstia and Rochinia) in the eastern

Pacific. An additional 7% (three genera - Picroceros, Sargassocarcinus and Leptomithrax) are western Pacific only. Two genera, Naxia and Notomithrax, both temperate, are mainly Australasian. Five genera (12%) (Anacinetops, Ephippias, Paramithrax, Tumulosternum and Paranaxia) are restricted to Australia; all are monotypic and part of the temperate fauna. Evidence of bipolarity or antitropicality in the Australian majid fauna is, I think, difficult to discern, although the genera Cyrtomaia, Zewa, Xenocarcinus, Pugettia, Sargassocarcinus, Eurynome, Rochinia, Hoplophrys and Leptomithrax may provide some evidence of such distribution patterns.

Of the other Australian crabs the two best known families are the Portunidae (Stephenson 1962) and the Grapsidae (Tesch, 1918, Banerjee 1960, Campbell and Griffin, in press). In both these families the existence of a few more or less widespread temperate species, such as Leptograpsus variegatus (Fabricius), Plagusia capensis de Haan, Macropipus corrugatus (Pennant), Ovalipes punctatus (de Haan) (last two also bipolar) and Nectocarcinus integrifrons (Latreille), should not be allowed to obscure the fact that the temperate representatives as a whole relate themselves most closely to the tropical faunas. These two families are proportionally worse represented in temperate regions of Australia than are the Majidae.

In conclusion it can be stated that the features shown by the Australian Majidae are similar to those shown by other Australian marine animals (see Ekman 1953). This is particularly true of the partitioning into a tropical fauna with tropical Indo-West-Pacific relationships and a temperate fauna related to the tropical fauna of Australia rather than to temperate faunas outside Australia. There is also agreement in the apparent position of transition areas and the geographical extent of the faunal provinces; only the Peronian province (central eastern Australia) (see Bennett and Pope 1953) may be of doubtful validity for the majids.

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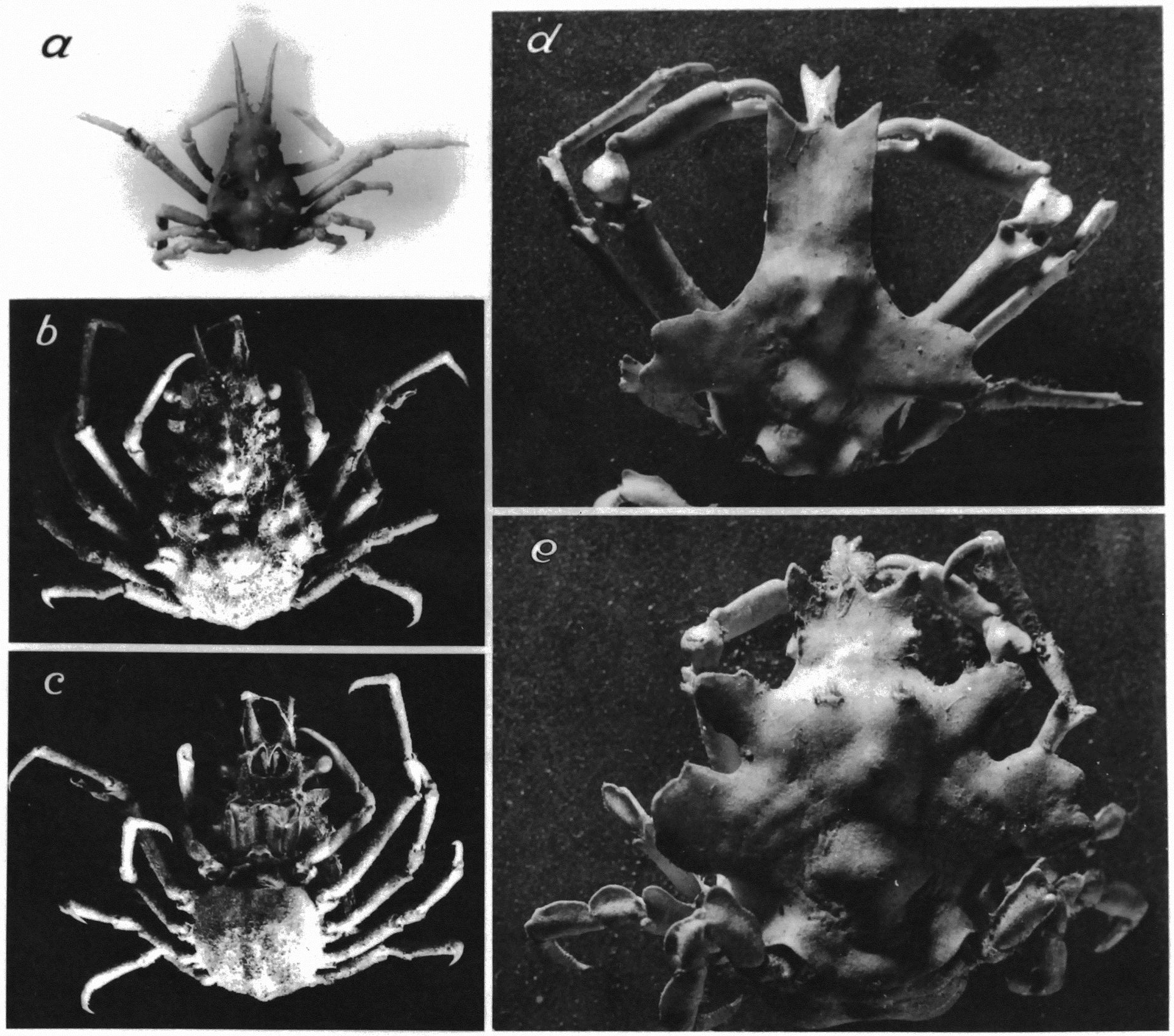
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PLATE 1

(a) *Hyastenus auctus* Rathbun. HOLOTYPE, male, carapace length from photo (including rostral spines in all cases) about 30 mm. Sulu Sea, Philippine Islands, *Albatross* Exped., U.S. National Museum no. 48214 (Photo: U.S. Nat. Mus.).

(b) *Hyastenus sebae* White. LECTOTYPE (selected on the advice of I. Gordon), dorsal view, female, carapace length from photo about 11.5 mm. Corregidor, Philippine Islands, British Museum (N.H.) no. 43.6 (Photo: British Museum).

(c) *Hyastenus sebae* White. LECTOTYPE, ventral view (Photo: British Museum).

(d) *Huenia bifurcata* Streets. Male, carapace length 22 mm, setae cleaned from shaft of rostrum only. New South Wales, Australian Museum no. P. 14961 (Photo: Anthony Healy).

(e) *Huenia bifurcata* Streets. Female, carapace length 21 mm, uncleaned. Port Jackson, N.S.W., Aust. Mus. no. G 5102 (Photo: Anthony Healy).


a


b

PLATE 2

(a) *Schizophrys aspera* (H. Milne Edwards). Dorsal view, male, carapace length 60.5 mm. Lord Howe Island, W.R.B. Oliver collection, Dominion Museum, Wellington (Photo: Athol Beswick).

(b) *Schizophrys aspera* (H. Milne Edwards). Ventral view of same specimen (Photo: Athol Beswick).

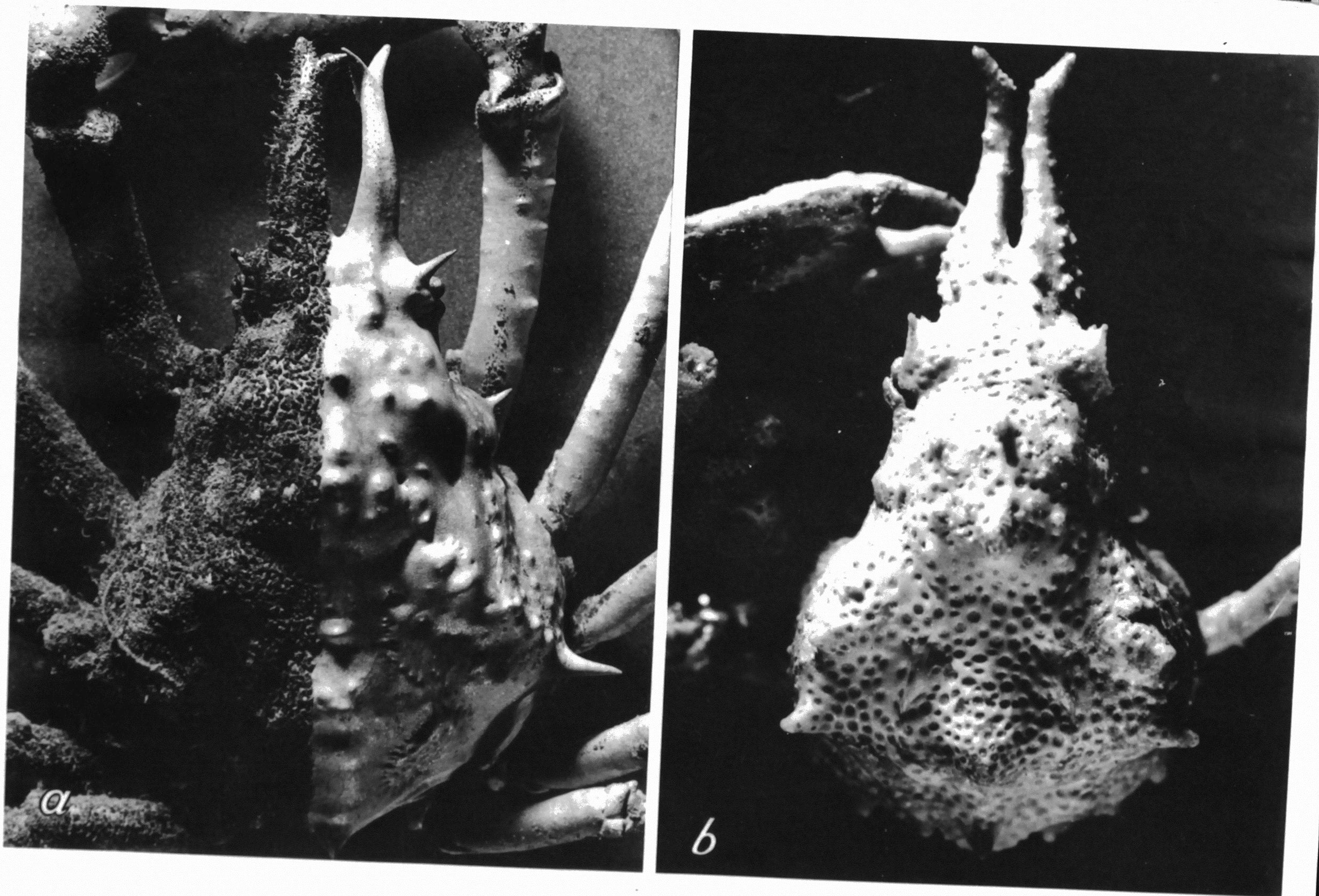
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PLATE 3

(a) Paranaxia serpulifera (Guérin). Male, carapace length 102 mm. Darnley Island, Torres Strait, Aust. Mus. no. G. 2469 (Photo: Anthony Healy).

(b) Tiarinia elegans Haswell. HOLOTYPE, male, carapace length 14.5 mm. Off Broughton Island, near Port Stephens, N.S.W., 25 fms. Aust. Mus. no. G. 5140 (Photo: Anthony Healy).

ap

shorter than in male, lateral branchial spine often greatly reduced, abdomen of female of 5 segments (Alcock 1895: 210; Sakai 1965: 81, pl. 36 fig. 1).

— Intestinal region with a strong tubercle. Lateral branchial spine with a tubercle above and in front of it..H. auctus Rathbun, 1916

Small; in Australia known only from near C. Jaubert (NW) in 12-14 fms; Philippines (Rathbun 1916: 543); figured here -pl.1a

55 (52) Carapace strongly tuberculate. Rostral spines almost as long as postrostral carapace length..H. brockii de Man, 1888

Medium; in Australia known only from Torres Strait (N); Indian O., Indo-Malaya; sublittoral (de Man 1888: 221, pl.7 fig. 1).

— Carapace weakly tuberculate or granular or sometimes smooth. Rostral spines usually ½ postrostral carapace length, sometimes longer..56

56 (55) Rostral spines 2/3 postrostral carapace length. A single medial gastric tubercle and several granules laterally....................................H. borradailei (Rathbun, 1907).

Medium; in Australia known only from C. Jaubert (NW); Indo-West-Pacific; sublittoral to shallow offshore; further distinguished by 5 gastric granules in a transverse row, body covered by a thick tomentum (Rathbun 1911: 251, pl.20 fig. 5).

ap

— Rostral spines ½ postrostral carapace length. Carapace with gastric and intestinal tubercles medially or else smooth...57

57 (56) Carapace completely smooth except for lateral branchial tubercle. Supraorbital eave produced as a blunt forwardly directed spine.............*H. irami* (Laurie, 1906)

Very small; in Australia known only from C. Jaubert (NW); Ceylon; sublittoral (Laurie 1906: 379, pl. 1 figs. 4,4a)

— Carapace with at least a trace of 1 or 2 medial tubercles in gastric, cardiac and intestinal regions. Supraorbital eave acute anteriorly but not forwardly produced..........58

58 (57) Rostral spines curved slightly outwards distally. Branchial regions with 2-3 small tubercles laterally including that at widest part of carapace....*H. convexus* Miers, 1884

Small; NE, N, NW; Indian O., Indo-Malaya; sublittoral to shallow offshore (Miers 1884: 196, pl. XVIII figs. B,b)

— Rostral spines curved slightly inwards distally. Branchial regions completely smooth laterally except for small spine at widest part of carapace...*H. espinosus* Borradaile, 1903

Small; in Australia known only from C. Jaubert (NW); Maldive Archipelago; sublittoral (Borradaile 1903: 688, pl. XLVII figs. 4a-d).

59 (44) Carapace armed with several prominent tubercles and generally a few spines. Supraorbital eave and postorbital lobe separated by a narrow fissure. Ambulatory legs smooth.... ....*Doclea* Leach, 1814

Tropical Indo-Pacific, 13: *D. profunda* Rathbun, 1918; small;

known only from a single ovigerous female taken in Great Australian Bight, south of Eucla (SW), in 250-450 fms; further distinguished by single cardiac and intestinal spine and single hepatic and branchial marginal spines, narrowly pyriform carapace unusual for this genus (Rathbun 1918: 16, pl. VII figs. 1,2).

— Carapace unevenly and indistinctly tuberculate, lacking spines. Supraorbital eave completely fused with postorbital lobe. Ambulatory legs armed with a few spines and tubercles.. .... *Perinia* Dana 1851

Widespread Indo-West-Pacific, monotypic: *P. tumida* Dana, 1851 (=*Parathoe rotundata* Miers, 1879); very small; NE; littoral; further distinguished by short, broad, apically inwardly curved rostral spines and denticulate dactyli (Miers 1879b: 16, pl. V fig. 2, 2a; Sakai 1938: 294, fig. 40).

60 (43) Supraorbital eave well expanded posterolaterally, separated from postorbital lobe by an extremely narrow fissure. Rostrum bifid for distal half only. Carapace armed with a few slender spines. Ambulatory legs long, the first at least twice carapace length, slender, smooth............................... ....2............. *Austrolibinia* n. gen.

India, New Guinea, Australia, 2: *A. gracilipes* (Miers, 1879) n. comb.; small: NE, N, NW; New Guinea; shallow offshore; further distinguished by 2 medial gastric and 1 medial cardiac spine, a broad, acute intestinal lobe and 2 dorsal branchial spines (Miers 1879b: 7, pl. IV figs. 4, 4a).

— Supraorbital eave weakly expanded posterolaterally, separated from postorbital lobe by a wide U sinus. Rostrum less than 1/6 postrostral carapace length, bifid for at least distal 2/3. Carapace armed with numerous, short, very coarse spines. Ambulatory legs little longer than carapace, stout, spinous.....................<u>Hoplophrys</u> Henderson, 1893

Tropical Indo-West-Pacific; see Alcock (1895), Sakai (1932), Buitendijk (1939); 2: <u>H. ogilbyi</u> McCulloch, 1908; small; in Australia known only from Moreton B. (NE); Indo-Malaya (Moluccas, Ceram),? Japan; sublittoral; further distinguished by simple spine at lateral branchial angle (McCulloch 1908: 51, pl. xii fig. 2,2a)

61 (1) Basal antennal article not specially expanded to form a floor to the orbit, which is formed by a supraorbital eave, a postorbital lobe and an intercalated spine between the two..Subfamily MAJINAE..................62

— Basal antennal article expanded to form a floor to the orbit which is formed by eave and postorbital lobe; intercalated spine present or absent....Subfamily MITHRACINAE.............81

62 (61) Postorbital lobe a simple acute spine more or less isolated from orbit and affording no concealment to cornea of eyestalk.63

— Postorbital lobe cupped, close to orbit and affording some concealment to cornea of retracted eyestalk...................66

63 (62) Rostral spines shorter than width at base, fused for basal 1/3. Postorbital spine no longer than intercalated spine. Basal antennal article slightly narrowed anteriorly, lateral

margin notched distally. Carapace very weakly tuberculate.
..........................*Paramithrax* H. Milne Edwards, 1834
Restricted to Australia, monotypic: *P. barbicornis* (Latreille, 1825) (=*Gonatorhynchus tumidus* Haswell, 1880); medium; SW, S, SE; littoral to shallow offshore; further distinguished by two small marginal branchial tubercles (Griffin 1963b: 137, figs. 7-14).

— Rostral spines longer than their width at base, distinct from base. Postorbital spine distinctly longer than intercalated spine. Basal antennal article of even width throughout, or produced into a lobe anterolaterally, not notched laterally or narrowed distally. Carapace spinous or densely tuberculate.
....64

64 (63) Chelipeds in adult male robust, merus tuberculate or spinous, carpus with a dorsal and lateral longitudinal ridge. Eyestalks not especially slender and hardly reaching postorbital spine.......................*Notomithrax* Griffin, 1963.........65
South Pacific to Juan Fernandez; review of species in Griffin (1963a); 5

— Chelipeds in both sexes slender and unarmed, carpus subcylindrical, lacking ridges. Eyestalks long and slender, reaching postorbital spine...*Maja* Lamarck, 1801
Tropical Indo-West-Pacific, E. Atlantic & Mediterranean, 15: *M. miersii* Walker, 1890; large; in Australia known only from C. Jaubert (NW); Singapore, Japan; sublittoral to

shallow offshore; further distinguished by 2 medial and 5 marginal spines (Sakai 1938: 298, pl. XXXVIII fig. 2)

65 (64) Carapace with both spines and tubercles dorsally. Hepatic margin with two spines, branchial margin with seven spines.. ....N. minor (Filhol, 1885) (=Paramithrax peronii; Haswell, 1882); large; SE, NE, New Zealand; sublittoral to lower shelf; further distinguished by spines of branchial margin being alternately large and small; usually thickly covered by algae, hydroids and sponges (Rathbun 1918: 18, pl. VIII)

— Carapace with numerous low tubercles dorsally. Hepatic and branchial margins each with three spines.................... ....N. ursus (Herbst, 1788) (=Paramithrax latreillei Miers, 1876); large; SE; New Zealand; littoral; hepatic and branchial marginal spines decrease in size posteriorly, body thickly hirsute (Griffin , in press, b, fig.).

66 (62) Postorbital lobe sometimes with spines or tubercles on posterior edge but not on anterior upper edge.................67

— Postorbital lobe with a prominent accessory spine on upper anterior edge near base......................................78

67 (66) Supraorbital eave seldom with a preorbital spine. Rostral spines straight but divergent, seldom more than 1/6 post-rostral portion of carapace in length. Carapace densely tuberculate, margins spinous. Chelipeds with merus and

carpus variously tuberculate.................................
..........................Leptomithrax Miers, 1876..........68
Australasia, Indo-Malaya, Japan; review of Australian and New Zealand species in Griffin (in press,b); 16; all Australian species except L. tuberculatus restricted to Australia.

— Supraorbital eave with a prominent preorbital lobe directed outwards or upwards. Rostral spines straight and divergent, or, more usually, outwardly curved distally, in length at least 1/4 postrostral portion of carapace. Carapace with a few scattered long or short spines or lamellae, otherwise smooth. Chelipeds with merus and carpus smooth or with well-developed longitudinal crests.........................
..........................Chlorinoides Haswell, 1880........73
Indo-West-Pacific; reviewed in detail in Griffin (in press, a); 12

68 (67) Intercalated spine not nearly reaching tip of antorbital spine, almost excluded from outer rim of supraorbital margin by distal approximation of antorbital spine and postorbital lobe. Ambulatory legs hardly longer than carapace..........69

— Intercalated spine reaching to tip of antorbital spine, not excluded from rim of supraorbital margin. Ambulatory legs at least 1½ times carapace length..........................71

69 (68) Sternum and abdomen smooth in adults and juveniles of both sexes. Carapace weakly tuberculate. Two marginal branchial spines.....................L. parvispinosus (Ward, 1933)
Medium; SE, NE; littoral; orbit becomes slightly more

open in larger specimens (Ward 1933: 392, pl. XXIII fig. 4)

— Sternum or abdomen, or both, excavated as rimmed pits in adult males and juveniles. Carapace strongly tuberculate. Three or four marginal branchial spines....................70

70 (69) Postorbital lobe acuminate. Four marginal branchial spines.. ....L. _tuberculatus_ (Whitelegge, 1900)
Medium to large; SE; New Zealand, Kermadecs; shallow offshore to lower shelf; Australian forms with short marginal and long dorsal spines (Whitelegge 1900: 146, pl. XXXIV figs. 1,2)

— Postorbital lobe truncate distally. Three marginal branchial spines.............L. _sternocostulatus_ (H.Milne Edwards, 1851)
Medium to large; S, SE, NE, NW; shallow offshore; further distinguished by sternal excavations being wholly segmental (Hale 1927: 137, fig. 137)

71 (68) Carapace narrowly pyriform, width no more than 3/4 post-rostral length. Postorbital lobe distally slender with a single small spinule close to tip and numerous small tubercles around base. First ambulatory leg twice carapace length.....................L. _globifer_ Rathbun, 1918
Large to very large; SW; lower shelf and slope to 120 fms; (Rathbun 1918: 23, pls. X, XI)

— Carapace broadly pyriform, at least in adult, width at least 2/3 postrostral length. Postorbital lobe subtriangular, distal portion not especially slender, a prominent spine or tubercle close to tip and another about halfway along posterior edge. First ambulatory leg no more than $1\frac{1}{2}$ times carapace length.. 72

72 (71) Mid-dorsal regions of carapace thickly covered by both spines and tubercles. Ambulatory meri with a blunt terminal dorsal lobe.......................<u>L. gaimardii</u> (H. Milne Edwards, 1834) (=<u>L. australiensis</u> Miers, 1876; <u>L. spinulosus</u> Haswell, 1880); very large; SW, S, SE; sublittoral to slope down to 450 fms; postorbital lobe with sharp spinules in juvenile and blunt tubercles in adult (Hale 1927: 135, fig. 135; Griffin 1963b: 133, figs. 1-6, pls. 6,7).

— Mid-dorsal regions of carapace smooth except for a few short, prominent spines. Ambulatory meri with a prominent sharp terminal dorsal spine......<u>L. waitei</u> (Whitelegge, 1900). Very large; SE; shallow offshore to lower shelf; postorbital lobe with sharp accessory spines in juveniles and adults (Whitelegge 1900: 143, pl. XXXIII).

73 (67) Preorbital lobe vertically directed upwards from base. Carapace with a few long spines but no lamellae. Rostral spines with a small spinule on dorsal surface near tip....... ....<u>C. tenuirostris</u> Haswell, 1880 Medium; restricted to Australia; NE, N; shallow offshore (Griffin, in press, a, fig.).

— Preorbital lobe outwardly directed, at least basally. Carapace with a few spines and some lamellae, particularly around margins and above orbit. Rostral spines without a spinule on dorsal surface.. 74

74 (73) Rostral spines straight, divergent, distal width less than twice basal width. Branchial margins with three spines and, anteriorly, a small lamellae. Ambulatory legs with numerous prominent tubercles dorsally arranged in rows.. ....*C. goldsboroughi* Rathbun, 1906
Medium; in Australia known from 2 specimens taken off N.S.W. coast in 70-120 fms; Hawaii (Rathbun 1906: 881, pl. XIV fig. 7)

— Rostral spines weakly or strongly outwardly curved, very divergent, distal width at least 2½ times basal width. Branchial margins with two spines posteriorly. Ambulatory legs smooth or minutely spinous..............................75

75 (74) Antorbital lobe a narrow, flattened, distally rounded lamella, preorbital lobe much wider and somewhat longer. Rostral spines weakly curved..76

— Antorbital and preorbital lobes subequal, acuminate. Rostral spines very strongly curved outwards distally...............77

76 (75) Preorbital lobe simple, acuminate. Rostral spines unarmed. Posterior intestinal margin with a short, cylindrical spine. ....*C. albanyensis* (Ward, 1933)
Medium; restricted to Australia, NE; sublittoral to shallow offshore (Ward 1933: 391, pl. XXIII fig. 3).

— Preorbital lobe wide distally, truncate or bifid. Rostral spines armed with several strong spines medially. Posterior intestinal margin with a wide, flattened lamella............ ....*C. spatulifer* (Haswell, 1882)

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(=_Acanthophrys_ _aculeatus_ A. Milne Edwards, 1865); medium; restricted to Australia, SW, S, SE; sublittoral to slope down to 250 fms (Hale 1927: 137, fig. 138).

77 (75) Preorbital spine simple. A single cardiac spine. Intestinal region with two medial spines..C. _aculeatus_ (H.Milne Edwards,1834) (=_Acanthophrys_ _aculeatus_ var. _armatus_ Miers, 1884); large; NE, N, NW; Indian O., Japan; sublittoral to lower shelf (Miers 1884: 193, pl. XVIII, fig. A)

— Preorbital lobe divided into two distinct spines. Cardiac region with a pair of widely divergent, outwardly curved spines. Intestinal region with a single spine..C. _longispinus_ (de Haan, 1839) (=_Paramithrax_ _coppingeri_ Haswell, 1880); large; SE, NE, NW; widespread Indo-West-Pacific; shallow offshore (Sakai 1965: 87, pl. 40 fig. 1).

78 (66) Carapace suborbicular. Rostrum exceedingly short, 1/8-1/20 postrostral carapace length, unarmed.._Cyclax_ Dana, 1851.................. 79

Widespread Indo-Pacific; detailed account in Forest & Guinot (1961); 2.

— Carapace pyriform. Rostrum of moderate length, more than 1/5 postrostral carapace length, bearing one or two spines or tubercles laterally near base.._Schizophrys_ White, 1847........80

Widespread Indo-West-Pacific; 2.

ap

— Carapace pyriform. Rostrum of moderate length, more than 1/5 postrostral carapace length, bearing one or two spines or tubercles laterally near base...Schizophrys White, 1847..........80

Widespread Indo-West-Pacific; 2.

79 (78) Intercalated spine distally with three subequal spinules. Basal antennal article with a strong accessory spine between anterolateral and anteromedial spines. Marginal spines of carapace granular almost to tip...C. suborbicularis (Stimpson, 1858)

(=Cyclomaia margaritata A. Milne Edwards, 1872); SW, NW; Seychelles to Tahiti; littoral (Forest & Guinot 1961: 15, figs. 5, 6, 10; pl. VI figs. 1,2)

— Intercalated spine triangular, granulate basally only. Basal antennal article lacking an accessory spine between main anterior spines. Marginal spines of carapace granular only at their bases.............C. spinicinctus Heller, 1861

Medium; SW, N, NE; E. Africa to Samoa; littoral (Forest & Guinot 1961: 15, figs. 7, 8, 11; pl. VI, fig. 3)

80 (78) Rostrum with a single lateral spine. Surface of carapace bearing a few groups of prominent tubercles, especially posteriorly and several spines...S. aspera (H. Milne Edwards, 1834)

Large; S, NE, N, NW, SW; widespread Indo-West-Pacific; littoral (Hale 1927: 134, fig. 139); also figured here - pl. 2a,b.

— Rostrum with two lateral spines or tubercles. Surface of carapace densely covered by low tubercles dorsally..S. dama (Herbst, 1804)

Large; SW, NW; Indo-Malaya; littoral (Yaldwyn, 1964, fig.)

81 (61) Intercalated spine present.....................................82

— Intercalated spine absent (possibly present in Paranaxia)....83

82 (81) Rostrum weakly deflexed, of two slender spines distinct from base.......................Entomonyx Miers, 1884

Indian O., Japan; monotypic: E. spinosus Miers, 1884 (=Acanthophrys spinosus; Balss, 1929); small; in Australia known only from Dampier I. (NW); shallow offshore and lower shelf; further distinguished by two marginal branchial spines and densely tuberculate chelipeds (Miers 1884:526, pl. XLVII fig. B; Sakai 1965: 88, pl. 40 fig. 2).

— Rostrum generally steeply deflexed, broad, lamellar, of two spines fused for at least basal third...Micippa Leach, 1817...............83

Tropical Indo-Pacific; see Miers (1885), Sakai (1938), Buitendijk (1939); 8.

83 (82) Eyestalks projecting laterally well beyond postorbital lobe. Rostrum of two distally distinct, truncate lobes.......................................M. tuberculosa (H. Milne Edwards,1834)

(=Micippa parvirostris Miers, 1879): small; restricted to Australia, S, SE; littoral; further distinguished by 4 large marginal branchial spines and broad antennal flagellum (Hale 1927: 140, fig. 142).

— Eyestalks reaching only to postorbital lobe. Rostrum of two acute spines, or distally notched.................... 84

84 (83) Rostrum terminating in two strong submedial lobes flanked by a short, broad, recurved spine. Carapace strongly tuberculate and lacking spines dorsally.................. 85

— Rostrum distally bifid or notched, without lateral spines. Carapace smooth or granular with a few tubercles or strongly tuberculate and spinous.................................. 86

85 (84) Orbit open below, a wide hiatus between smooth basal antennal article and postorbital lobe. Anterolateral borders of carapace with 8-10 spines, anterior spines broad, posterior spines acuminate...........*M. platipes* Rüppell, 1830 (=*M. spatulifrons* A. Milne Edwards, 1872); small to medium; NE; widespread Indo-West-Pacific; littoral and sublittoral (Sakai 1938: 316, fig. 46; pl. XXXII fig. 2; pl. XXXVIII fig. 4; Buitendijk 1939: 254, text-fig. 22, pl. X figs. 2,4).

— Orbit closed below, strongly tuberculate basal antennal article in broad contact with postorbital lobe. Anterolateral borders with 3-6 acuminate spines or spinules.......................................*M. phillyra* (Herbst, 1803) (=*M. superciliosa* Haswell, 1880; *Paramicippa asperimanus* Miers, 1884; *M. mascarenica* var. *nodulifera* Baker, 1905); medium; SW, NW, N,S; widespread Indo-West-Pacific; littoral and sublittoral (Haswell 1880a: 446, pl. 26 figs. 2, 2a; Buitendijk 1939: 253, text-fig. 21, pl. X figs. 1,3; Sakai 1965: 90, pl. 42, fig. 1).

86 (84) Rostrum of two, outwardly curved, sharply pointed spines, distinct for distal half...M. thalia (Herbst, 1803) (=M. inermis Haswell, 1880); SW, N, NE; widespread Indo-West-Pacific; medium; sublittoral to shallow offshore; further distinguished by 2 medial gastric, 2 submedial cardiac, 1 dorsal branchial and 9 marginal branchial spines (Haswell 1880a; 445 pl. 26 figs. 3,3a; Sakai 1965: 90, pl. 42 fig. 3)

— Rostral spines fused throughout their length..............87

87 (86) Carapace minutely granular dorsally with a few tubercles, anterolateral margins with about 3 small spinules. Merus of cheliped dorsally carinate; ambulatory legs tuberculate..... ....M. curtispina Haswell, 1880 Small; NE, N; Singapore; sublittoral; further distinguished by basally vertically deflexed and apically inflexed rostrum (Haswell 1880a: 446, pl. 25 figs. 1, 1a).

— Carapace strongly tuberculate and spinous, anterolateral margins with about 9 prominent spines of various sizes. Merus of chelipeds smooth; ambulatory meri smooth except for a terminal dorsal spine..M. spinosa (Stimpson, 1857) (=Paramicippa affinis Miers, 1879); medium; restricted to Australia, S, SE; sublittoral and shallow offshore (Hale 1927: 140, fig. 143)

83 (81) Supraorbital eave separated from postorbital lobe by a wide fissure, not expanded anteriorly into a preorbital spine or lobe. Rostral spines short, broad..........................

..........................*Tumulosternum* McCulloch, 1913
Restricted to Australia; monotypic; *T. longimanus* Haswell, 1880); medium; SE; littoral (Haswell 1880a: 444, pl. XXVI; McCulloch 1913: 334, fig. 45)

— Supraorbital eave separated from postorbital lobe by a very narrow fissure or completely unexpanded posterolaterally, armed with a prominent preorbital spine or lobe. Rostral spines moderately to very long..............................89

89 (88) Rostrum of two distinct, subparallel spines, each apically bifid. Basal antennal article narrowed anteriorly. Carapace weakly tuberculate. Ambulatory legs smooth...............
..........................*Paranaxia* Rathbun, 1924
Restricted to Australia; monotypic: *P. serpulifera* (Guérin, 1829); very large; SW, NW, N; sublittoral to shallow offshore (Rathbun 1924: 7, Montgomery 1931; 417); figured here - pl. 3a.

— Rostrum of two spines, contiguous throughout their length or at most only apically divergent. Basal antennal article with anterolateral angle forwardly produced. Carapace with groups of distinct or confluent tubercles dorsally. Ambulatory legs tuberculate....*Tiarinia* Dana, 1851............90
Tropical Indo-West-Pacific; see Stimpson (1907), Sakai (1938), Buitendijk (1939); 6.

90 (89) Rostrum with two or three lateral spines close to base. Carapace bearing numerous coarse tubercles dorsally..........
..........................*T. angusta* Dana, 1851
Indo-Malaya, Japan; littoral; further distinguished by 3

— Rostrum unarmed. Carapace smooth, uneven, or with distant tubercles...91

91 (90) Rostrum moderately long, about 1/3 postrostral portion of carapace...................T. elegans Haswell, 1882

Medium; known only from off Broughton I., Pt. Stephens (SE) in 25 fms; further distinguished by 2-3 conical submarginal branchial tubercles (Haswell 1882c: 29); figured here - pl. 3b.

— Rostrum short, less than 1/5 postrostral portion of carapace...92

92 (91) Carapace with distinct erect tubercles and granules dorsally, branchial region with six obtuse tubercles laterally...................................T. cornigera (Latreille, 1825)

(=T. mammillata Haswell, 1880); medium to large; NW; Indian O., Indo-Malaya, Japan; littoral; carapace very wide - width equal to postrostral length (Sakai 1965: 91, pl. 42 fig. 2; Buitendijk 1939: pl. XI fig. 1)

— Carapace with confluent depressed tubercles or smooth dorsally, branchial regions with five, or fewer, acute tubercles laterally...93

93 (92) Branchial regions with five large tubercles laterally. Preorbital spine quite stout. Seventh abdominal segment in male wider than long.......T. gracilis Dana, 1852

(?=T. depressa Stimpson, 1857); medium; SE, NE; Indo-Malaya Japan; littoral; further distinguished by 3 large, subequal, blunt tubercles on posterior margin (Stimpson 1907: 12, pl. III fig. 2; Sakai 1938: 321, fig. 49; Buitendijk 1939: 259, text-fig. 26, pl. XI fig. 2)

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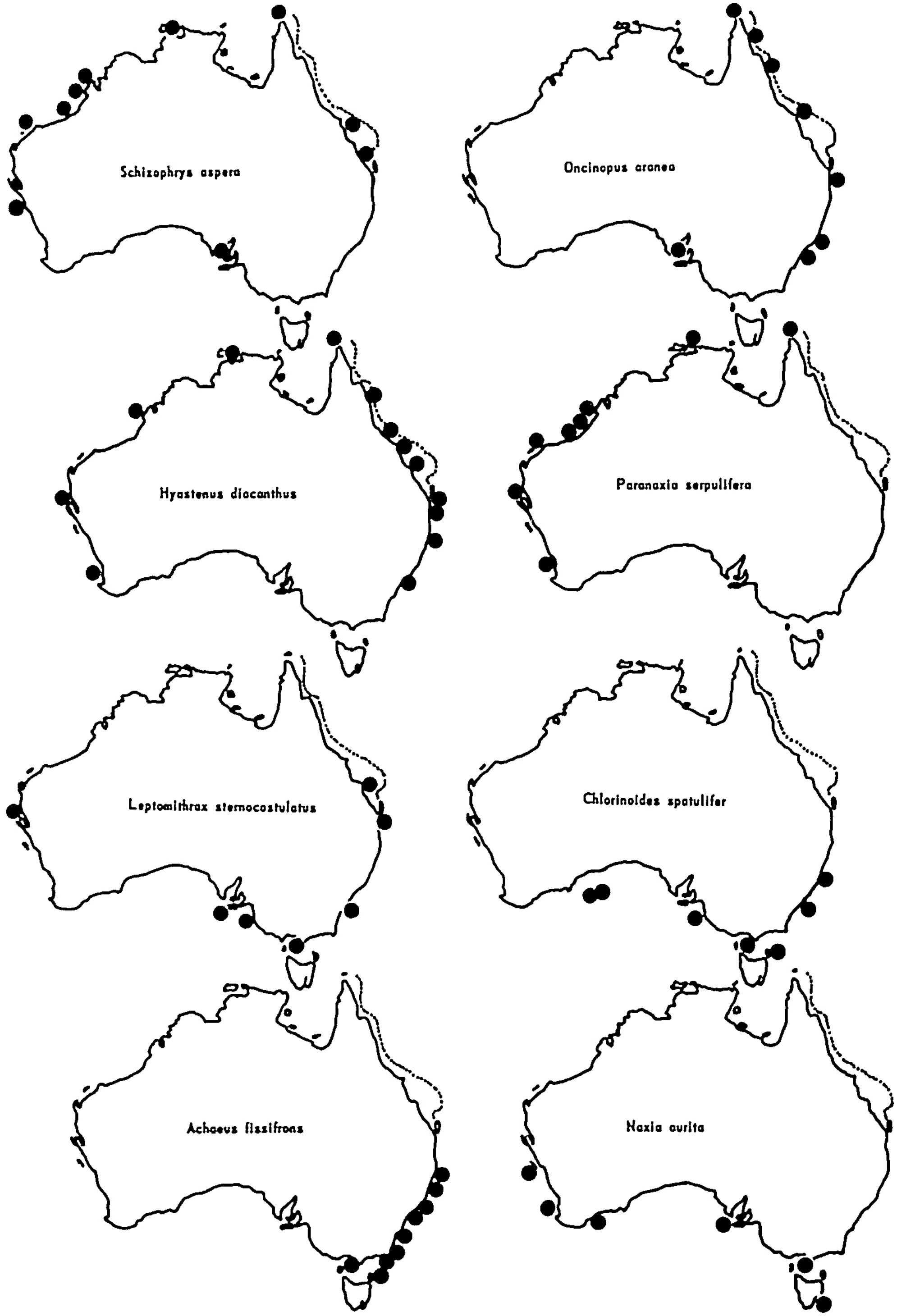
— Branchial regions with a single sharp spine at widest part of carapace laterally. Preorbital spine very slender. Seventh abdominal segment in male much longer than wide...... ....*T. tiarata* (Adams & White, 1848) Small; N. Guinea; West-Pacific; sublittoral; further distinguished by completely straight rostral spines (Sakai 1938: 322, pl. XXXVIII fig. 7).

VII. ZOOGEOGRAPHY

Two features of the Australian majid fauna stand out: 1) the relatively large proportion of species (31%) which have been recorded only once from a single locality in Australia; and 2) the very clear partitioning of the fauna into tropical and temperate components.

Of the poorly known species, 12 are not known outside Australia whilst 16 are very widely distributed species known from several parts of the Indo-West-Pacific. Ten of the species were recorded by Rathbun, either from the Endeavour collections or from near Cape Jaubert (Rathbun 1918; 1924), two were recorded by Whitelegge (1900) and two by Baker 1905; 1906). Fewer species have been recorded from Western Australia than from eastern coasts.

The geographical boundaries between the tropical and temperate faunas are in the form of very broad transition areas (containing a mixture of tropical and temperate species) extending from Shark Bay to Fremantle on the west coast and from about Mast Head Island to Cape Howe on the east. Slightly narrower transition areas between south-eastern and south-western provinces on the one hand and between


Schizophrys aspera
Oncinopus aranea
Hyastenus diacanthus
Paranaxia serpulifera
Leptomithrax sternocostulatus
Chlorinoides spatulifer
Achaeus fissifrons
Naxia aurita

TEXT-FIG. 3 Known Australian distribution of eight species of majid spider crab. (Each circle represents a single recorded locality).

north-eastern and north-western provinces on the other, appear to exist just west of Kangaroo Island in the south and around Torres Strait in the north. The four faunal provinces which emerge here are in general agreement with the findings of workers on other groups of marine animals (see Bennett & Pope 1953). Two points should be mentioned here; 1) the Spencer Gulf area of South Australia shows a very close affinity with the rest of south-eastern Australia but possesses five species which are tropical and not otherwise known from temperate latitudes (Oncinopus aranea, Anacinetops stimpsoni, Huenia proteus, Schizophrys aspera and Micippa philyra); 2) the Torres Strait fauna is a mixture of species otherwise known from north-eastern and to a lesser extent north-western, Australia with very few species confined to the region.

The tropical fauna is clearly part of that of the Indo-West-Pacific and possesses few species restricted to Australia. The first feature is borne out most strikingly by the fact that a larger proportion of it is shared with other Indo-West-Pacific areas than with temperate Australian provinces. Thus, of the north-eastern species only 18% extend southward compared with 50% which are shared with the Indian Ocean, 47% with Japan and 36% with Indo-Malaya. Similarly, for the north-western fauna, 28% extend southward whereas 72% are shared with the Indian Ocean, 48% with Japan and 60% with Indo-Malaya. However, the proportion of species which are distributed throughout the Australian tropical is not very high. For example 42% of the species found in north-eastern Australia are shared with north-western Australia and the proportion falls to 29% if Torres Strait is excluded. Indian Ocean species are represented to approximately equal extents (about 60%)

in both the north east and north west but the Japanese species are definitely best represented in the north east (also about 60%). Widespread Indo-West-Pacific species which are also widely distributed in the Australian tropics include _Oncinopus aranea_, _Menaethius monoceros_, several species of _Hyastenus_, _Schizophrys aspera_, two species of _Chlorinoides_, three of _Micippa_ and two of _Tiarinia_.

The low degree of restriction in the tropical fauna is evidenced by fewer than 30% of the species in either of the tropical provinces which are not found outside Australia and about 30% which are restricted to any one province. Restricted Australian species found in the tropics include species of _Zewa_, _Hyastenus minimus_, _Phalangipus australiensis_ and two species of _Chlorinoides_.

The temperate provinces contain fewer species and overall there is a much greater restriction of these species both to Australia and to particular provinces. Thus, only nine species are found in both south-western and south-eastern Australia out of a total of 34 south-eastern and 20 south-western species; 40% of the south-eastern and 50% of the south-western species are not known outside Australia. Eight species appear to be widespread temperate forms (two species of _Naxia_, _Ephippias endeavouri_, _Paratymolus latipes_, two species of _Leptomithrax_ and _Chlorinoides spatulifer_). The relationships of the temperate species are either with tropical Australia (e.g., species of _Paratymolus_, _Zewa_, _Huenia_, _Xenocarcinus_, _Hyastenus_, _Chlorinoides_ and _Micippa_) or with the Indo-West-Pacific (e.g. species of _Achaeopsis_, _Platymaia_, _Cyrtomaia_, _Pugettia_, _Doclea_, _Eurynome_ and _Leptomithrax_). The relationships with temperate regions outside Australia are slight. Only one species which

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does not have a tropical distribution, Achaeopsis thomsoni, is shared with South Africa. Five species, all of which are found in south-eastern Australia, are shared with New Zealand. Of the nine genera shared with New Zealand, seven are more or less widespread in the Indo-West-Pacific. The strong restricted element in the Australian temperate fauna is exemplified by species of Naxia, Ephippias endeavouri, Paramithrax barbicornis and Tumulosternum longimanus. Of the 37 species restricted to Australia, 69% are temperate.

If only species which penetrate the transition zones between tropical and temperate regions are considered, there is indeed only a very slight partitioning of the fauna into eastern and western elements. Such eastern species probably number no more than six (e.g. Naxia tumida and Notomithrax minor) and western ones no more than five (e.g. Paranaxia serpulifera and Schizophrys dama). If more steno-thermal species are considered a division between eastern and western regions is quite clear.

Distant relationships of the fauna are shown, at the specific level, by nine species shared with South Africa, 10 with the Red Sea and eight with Hawaii; one species, Achaeopsis thomsoni, is also found in the Atlantic. The vast majority of these widespread species are represented in the tropical fauna of Australia.

The zoogeographical features shown by the species are strongly emphasized at the generic level. Thus 58% of the 43 genera have widespread tropical Indo-West-Pacific representation. A further 16%, also represented in the Indo-West-Pacific, have wider relationships, four genera (Achaeus, Achaeopsis, Eurynome and Maja) being found in the Atlantic and three (Pugettia, Herbstia and Rochinia) in the eastern

Pacific. An additional 7% (three genera - Pleroceros, Sargassocarcinus and Leptomithrax) are western Pacific only. Two genera, Naxia and Notomithrax, both temperate, are mainly Australasian. Five genera (12%) (Anacinetops, Enhippias, Paramithrax, Tumulosternum and Paranaxia) are restricted to Australia; all are monotypic and part of the temperate fauna. Evidence of bipolarity or antitropicality in the Australian majid fauna is, I think, difficult to discern, although the genera Cyrtomaia, Zewa, Xenocarcinus, Eurettia, Sargassocarcinus, Eurynome, Rochinia, Hoplophrys and Leptomithrax may provide some evidence of such distribution patterns.

Of the other Australian crabs the two best known families are the Portunidae (Stephenson 1962) and the Grapsidae (Tesch 1918, Banerjee 1960, Campbell and Griffin, in press). In both these families the existence of a few more or less widespread temperate species, such as Leptograpsus variegatus (Fabricius), Plagusia capensis de Haan, Macropipus corrugatus (Pennant), Ovalipes punctatus (de Haan) (last two also bipolar) and Hectocarcinus integrifrons (Latreille), should not be allowed to obscure the fact that the temperate representatives as a whole relate themselves most closely to the tropical faunas. These two families are proportionally worse represented in temperate regions of Australia than are the Majidae.

In conclusion it can be stated that the features shown by the Australian Majidae are similar to those shown by other Australian marine animals (see Ekman 1953). This is particularly true of the partitioning into a tropical fauna with tropical Indo-West-Pacific relationships and a temperate fauna related to the tropical fauna of Australia rather than to temperate faunas outside Australia. There is also agreement in the apparent position of transition areas and the geographical extent of the faunal provinces; only the Peronian province (central eastern Australia) (see Bennett and Pope 1953) may be of doubtful validity for the majids.

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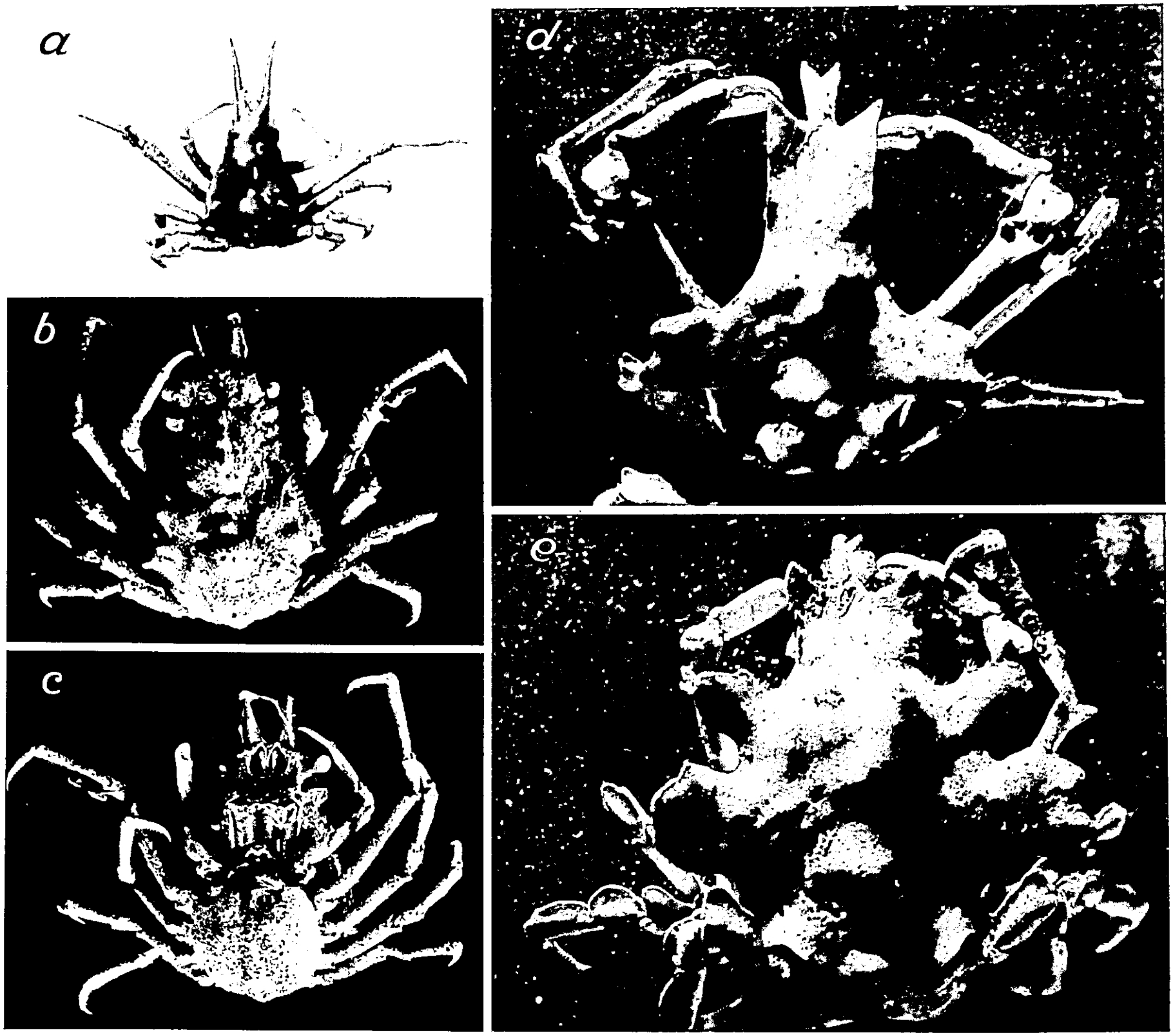
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PLATE 1

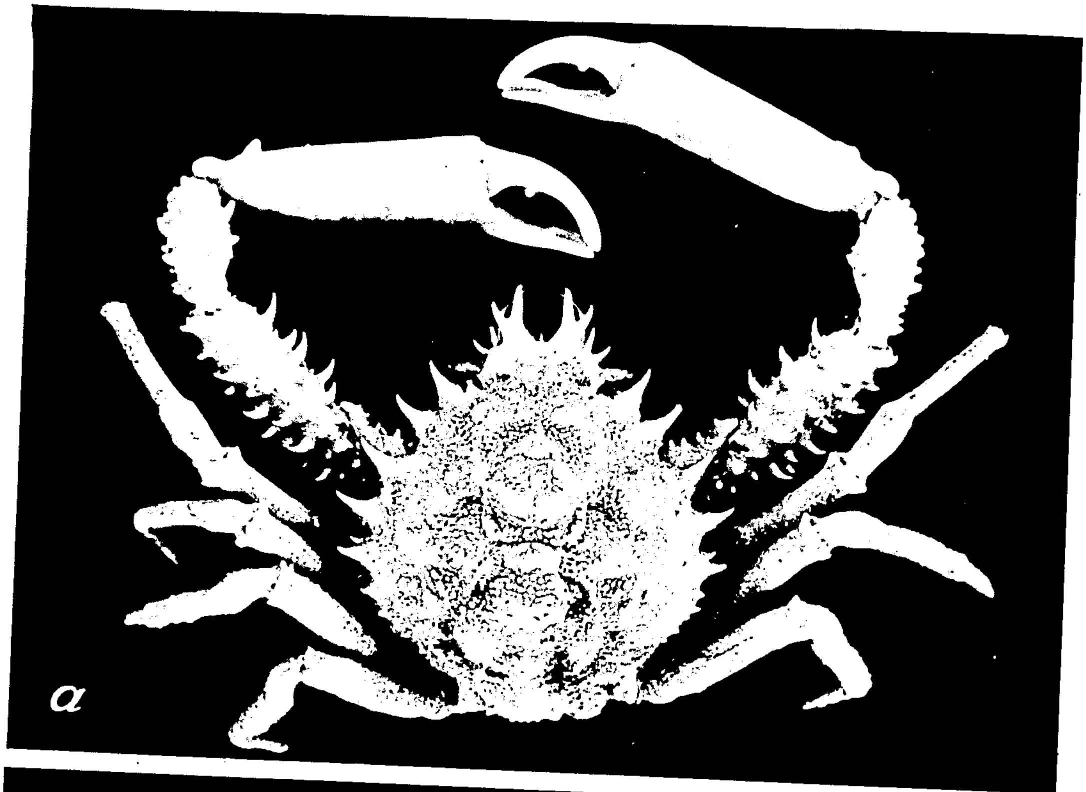
(a) Hyastenus auctus Rathbun. HOLOTYPE, male, carapace length from photo (including rostral spines in all cases) about 30 mm. Sulu Sea, Philippine Islands, Albatross Exped., U.S. National Museum no. 48214 (Photo: U.S. Nat. Mus.).

(b) Hyastenus sebae White. LECTOTYPE (selected on the advice of I. Gordon), dorsal view, female, carapace length from photo about 11.5 mm. Corregidor, Philippine Islands, British Museum (N.H.) no. 43.6 (Photo: British Museum).

(c) Hyastenus sebae White. LECTOTYPE, ventral view (Photo: British Museum).

(d) Huenia bifurcata Streets. Male, carapace length 22 mm, setae cleaned from shaft of rostrum only. New South Wales, Australian Museum no. P. 14961 (Photo: Anthony Healy).

(e) Huenia bifurcata Streets. Female, carapace length 21 mm, uncleaned. Port Jackson, N.S.W., Aust. Mus. no. G 5102 (Photo: Anthony Healy).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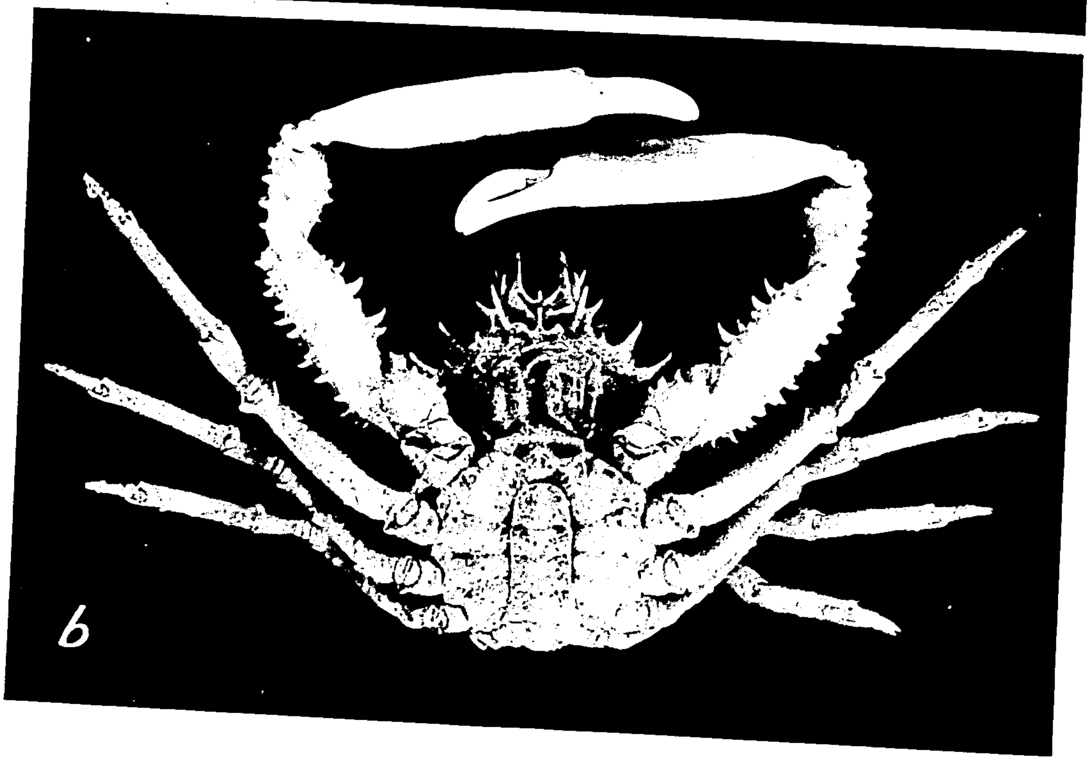
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PLATE 2

(a) Schizophrys aspera (H. Milne Edwards). Dorsal view, male, carapace length 60.5 mm. Lord Howe Island, W.R.B. Oliver collection, Dominion Museum, Wellington (Photo: Athol Beswick).

(b) Schizophrys aspera (H. Milne Edwards). Ventral view of same specimen (Photo: Athol Beswick).


a
b

PLATE 3

(a) *Paranaxia serpulifera* (Guérin). Male, carapace length 102 mm. Darnley Island, Torres Strait, Aust. Mus. no. G. 2469 (Photo: Anthony Healy).

(b) *Tiarinia elegans* Haswell. HOLOTYPE, male, carapace length 14.5 mm. Off Broughton Island, near Port Stephens, N.S.W., 25 fms. Aust. Mus. no. G. 5140 (Photo: Anthony Healy).